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U. S. DEPARTMENT OF AGRICULTURE.

BUREAU OF PLANT INDUSTRY—BULLETIN NO. 102.

B. T. GALLOWAY, *Chief of Bureau.*

MISCELLANEOUS PAPERS.

I. SUMMARY OF RECENT INVESTIGATIONS OF THE VALUE OF CACTI AS STOCK FOOD.
By DAVID GRIFFITHS, *Assistant Agrostologist,* and R. F. HARE, *Chemist, New Mexico College of Agriculture and Mechanic Arts.*

II. A SUCCESSFUL DAIRY FARM.
By L. G. DODGE, *Scientific Assistant.*

III. PLANNING A CROPPING SYSTEM.
By W. J. SPILLMAN, *Agriculturist.*

IV. THE APPLICATION OF VEGETATIVE PROPAGATION TO LEGUMINOUS FORAGE PLANTS.
By J. M. WESTGATE, *Assistant Agrostologist,* and GEORGE W. OLIVER, *Plant Propagator.*

V. THE CONTROL OF TEXAS ROOT-ROT OF COTTON.
By C. L. SHEAR, *Pathologist,* and GEORGE F. MILES, *Scientific Assistant.*

VI. THE HISTORY OF THE COWPEA AND ITS INTRODUCTION INTO AMERICA.
By W. F. WIGHT, *Assistant Botanist.*

VII. A NEW METHOD FOR THE DETERMINATION OF NICOTINE IN TOBACCO.
By WIGHTMAN W. GARNER, *Scientific Assistant.*

ISSUED SEPTEMBER 9, 1907.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1907.

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[Continued on page 3 of cover.]

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[a] The seven papers constituting this bulletin were issued in separate form on January 4, January 30, March 14, March 23, March 30, June 10, and July 6, 1907, respectively.

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MISCELLANEOUS PAPERS.

SUMMARY OF RECENT INVESTIGATIONS OF THE VALUE OF CACTI AS STOCK FOOD.[a]

By DAVID GRIFFITHS, *Assistant Agrostologist, Farm Management Investigations, Bureau of Plant Industry,* and R. F. HARE, *Chemist, New Mexico College of Agriculture and Mechanic Arts.*

INTRODUCTION.

In connection with introductions, the improvement of species, and a general study of the economic relationships of native and introduced species of cacti the authors have jointly undertaken a somewhat critical comparison of the species of this group from a forage standpoint. In order to make the chemical work worth while it has been necessary to put the characterizations of the different forms and species in such condition that they are recognizable to others. This could only be done by the use of copious notes in connection with each, for names are of uncertain meaning and in many cases will be of uncertain significance in this group of plants for a long time to come. The chemical side of the investigations seems to be essential, for when these studies were begun there was but little literature dealing with the cacti from a forage standpoint.

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[a] In two publications of the United States Department of Agriculture (Bulletin No. 74 of the Bureau of Plant Industry and Bulletin No. 91 of the Bureau of Animal Industry) the value of the cacti as forage plants has been demonstrated. Since these plants are known to possess important economic value more knowledge concerning them is desirable. As a basis for future investigations, the Bureau of Plant Industry and the Agricultural Experiment Station of New Mexico have collected specimens of these plants and their fruits from a wide area, from which a large number of chemical analyses have been made. The results are detailed in the following pages, which contain 187 fodder analyses and 26 complete ash analyses. The territory from which the material was collected extends from central Texas to California and southward to the central plateau of Mexico.

Attention is called to the fact that the apparent high content of fats and protein in the fruit of certain species is due to the large amount of these classes of nutrients found in the seed. As these seeds are surrounded by a dense layer of wholly indigestible tissue, the high content of ether extract and protein is misleading. The analyses show that the fodder value of the fruit of cholla (*Opuntia fulgida*) especially is little more than that of the stems. It will be seen that in chemical composition the different forms of cactus compare favorably with ordinary green fodders and root crops.

There are many points of special interest in connection with the ash analyses, particularly the high content of potash, magnesium, and calcium. Although the cane cacti show a relatively higher food value, practical considerations relating to growth and ease of propagation render them of less value than the prickly pear, except in certain limited localities where they are especially abundant.—W. J. SPILLMAN, *Agriculturist in Charge of Farm Management Investigations.*

The investigations have been conducted in cooperation between the Office of Farm Management Investigations of the Bureau of Plant Industry and the Agricultural Experiment Station of New Mexico for the purpose of determining, if possible, the extent of variation and the nature of the food constituents of the different species which are likely to be utilized as food for stock. The plants are grouped under three general headings—prickly pears, cane cacti, and miscellaneous—the first group being by far the most important, though the second is largely utilized in sections where its different representatives grow. Three or four members of this group have been fed to stock with more or less success. The third group consists of miscellaneous species from other cactus genera, which on the whole are but little utilized as stock feed, although it is clearly shown that some of the species have been fed in rare instances. The interest in this group is largely a matter of comparison with the others.

Details of the investigations are published in Bulletin No. 60 of the Agricultural Experiment Station of New Mexico.

THE SAMPLES OF CACTI ANALYZED.

Considerable importance is attached to the method of sampling, it being recognized that uniform samples of such succulent and variable plants are difficult to secure. It appeared more logical, therefore, to describe the samples in such a way as to give other investigators and the reader an accurate idea of the portion of the plant used in the chemical analysis. The sample is indicated by a formula—for example (2–1–4–3–5) 3—in which the left-hand figure indicates the number of terminal joints, the second number from the left the number of joints next to the terminal joint, and so on, the figure outside of the parentheses indicating the number of plants from which the sample was collected. All samples were forwarded to the laboratory in tin cans from which a minimum of evaporation took place. They were prepared by first being sliced open, so as to expose a maximum of cut surface, and dried by artificial heat at a temperature of not more than 70° C. The spines were then singed off by a small flame of complete combustion, care being taken neither to deposit combustion products upon nor injure the specimens. In the analyses the methods of the Association of Official Agricultural Chemists were followed, with the exception of a few modifications in the determination of certain ash constituents.

WATER CONTENT.

A collection of samples for chemical analysis was begun in 1904, and a fairly complete set was secured during that year; but, owing to the uncertainty due to the analysis of single samples, these were nearly all duplicated in 1905, in most cases from the same localities.

Fortunately there was a great difference between the rainfall during the months from January to March of 1904 and 1905. The effect upon the water content of the plants is fairly well illustrated in the different tables of analyses, although no special effort was made to collect the samples for the purpose of showing this feature in detail. There are some apparent exceptions to the rule that the samples collected in 1904 contain more water than those collected in 1905; but this may be accounted for in some cases by the difference in the portions of plant collected or in other cases possibly by local conditions. The amount of water in the different samples analyzed varied from 60.99 to 95.5 per cent. The miscellaneous group is relatively more succulent than either of the other two, the average amount of water being 87.88 per cent, while the prickly pears averaged 84.26 per cent and the cane cacti 78.47 per cent. As a rule, the fruit contained more water than the stems and the younger growth more than the older.

The difference in the species in the field during a dry and a wet season is very marked, and even prickly pear has its limit of drought endurance. Experience in southern Texas demonstrates that it is much reduced in value during very prolonged dry seasons, for it becomes tough and leathery. "Fat pear" is largely the result of distention of the tissues by water. Some species, *Opuntia fulgida* especially, when a favorable moist season follows an exceptionally dry one, will absorb so much water that the fruits and young joints become ruptured by the excessive turgidity, and this often occurs with the fruit of nopal camueso and other cultivated Mexican species.

ASH CONTENT.

Plants grown in the arid and semiarid Southwest, where there is an abundance of soluble salts in the soil, are found to contain more ash than those grown in regions of frequent rainfall. The cacti are certainly no exceptions to this rule. The average ash in the air-dried stems and fruits of the prickly pears analyzed amounts to 18.25 per cent, for the cane cacti 15.50 per cent, and for the miscellaneous group 13.54 per cent, one sample running as high in ash as 33.8 per cent of the air-dried substance. These averages would be still higher if they did not include the ash of fruits, which always contain less ash than the stems. The average ash in the air-dried fruits of the prickly pears, for instance, is 13.21 per cent, which is 5.4 per cent less than is contained in an average of both stems and fruits of this group and 6.35 per cent less than is in the stems alone. It is the seed which is especially low in ash, the fleshy portion resembling the stem more closely so far as its ash content is concerned. This is brought out very forcibly in samples Nos. 8022*a* and 8022*b*, the former being the fleshy

portion and the latter the seed of *Opuntia phaeacantha*. The fleshy portion contained 25.60 per cent of ash, while the seed contained only 1.77 per cent.

The elements of the ash are present in about the same proportion as in the ash of other plants, except potassium, magnesium, and calcium, which are found in large amounts. It is probably the presence of these salts, coupled with the high water content, that causes cattle to scour when fed on an exclusive roughage ration of these plants.

In the following table there is given a complete analysis of the ash of a few of the samples, together with the results of the analysis of a composite sample, and an average of all the ash analyses made. Complete ash analyses were made of 26 samples besides the composite, which was a mixture prepared by carefully igniting in a muffle two grams of the ash of each of the 187 samples of cactus analyzed.

TABLE I.—*Chemical analyses of representative samples of cacti.*

Number of sample.	Scientific name of caotus.	Locality.	Date of collection.	Formula.[a]	Total ash in air-dry plant.	Carbon.	Sand.
					P. ct.	*P. ct.*	*P. ct.*
6255	Opuntia fulgida	Santa Catalina Mountains, Ariz.	May 4, 1904	(6-6)	14.25	.74	1.65
6331	Echinocereus enneacanthus	Eagle Pass, Tex.	May 10, 1904	Plant	17.78	.26	3.31
3000	Opuntia macrocentra	Garfield, N. Mex.	July 11, 1904		16.45	.62	4.27
6699	Cereus giganteus	Tucson, Ariz.	July 28, 1904		15.75	.17	.44
7515	Opuntia lindheimeri	Encinal, Tex.	Jan. 17, 1905	(2-1-1)3	21.05	.14	.29
	Composite					.38	3.17
	Average of all ashes				19.65	.40	2.40

Number of sample.	Scientific name of cactus.	Pure ash.												
		Iron (Fe).	Aluminum (Al).	Manganese (Mn).	Calcium (Ca).	Magnesium (Mg).	Potassium (K).	Sodium (Na).	Silicic acid radical (SiO_3).	Phosphoric acid radical (PO_4).	Sulphuric acid radical (SO_4).	Chlorin (Cl).	Carbonic acid radical (CO_3).	Total.
		P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
6255	Opuntia fulgida	0.21	0.53	0.09	24.31	8.10	11.89	0.00	0.63	2.54	2.00	1.33	42.73	94.36
6331	Echinocereus enneacanthus.	.31	.13	.09	22.66	5.07	16.61	.62	.80	1.20	2.35	2.90	42.63	95.37
3000	Opuntia macrocentra.	.53	.00	.56	24.75	8.25	8.33	1.57	1.56	2.14	1.16	.95	44.80	94.60
6699	Cereus giganteus.	.30	.07	.15	31.64	5.78	6.66	.00	.37	.88	4.12	3.32	41.06	94.55
7515	Opuntia lindheimeri.	.20	.00	.49	26.71	2.27	14.22	.35	.43	1.11	1.15	2.15	49.12	98.26
	Composite.	.36	.31	.83	28.90	6.85	10.49	.47	1.90	2.70	1.94	2.20	33.76	90.71
	Average of all ashes.	.31	.24	.36	27.38	5.31	9.71	.42	1.58	1.39	1.64	1.84	45.90	95.75

[a] For explanation of formula, see page 6.

FOOD VALUE OF DIFFERENT PARTS OF THE PLANT.

The opinion is prevalent in southern Texas that the old woody stems of *Opuntia lindheimeri* fed there are much more valuable as a stock food than the younger growths. So firmly do many believe this that they practice cutting off and throwing away two or three of the terminal joints when feeding. In Mexico, on the contrary, the young growth is always fed; but there the species are commonly much larger and stouter, and the trunks are altogether too woody to be fed even if it were desirable to do so. The reasons for the opinions current in Texas are rather clearly brought out in the analyses. The younger growth has a relatively higher water content, and therefore probably causes more scouring, which is the only evil influence overcome by a rejection of it. On the other hand, the old stems contain a much larger proportion of fiber and are really of less forage value.

Guthrie,[a] after comparing his own analysis of the stems of four Australian species with the analysis of fruits made by Wolf, concludes that the latter are of less forage value than the stems, because they contain a smaller proportion of nutritious substance and more crude fiber. Forbes,[b] on the other hand, concludes from analyses of Arizona cylindrical-jointed species that the fruits of these species are relished by cattle on account of their high ether extract (including fats). Our analyses show that the ether extract is mainly a constituent of the seeds, and since these pass through cattle undigested can contribute nothing to either the palatability or nutritive value of this part of the plant. That the seed is not digested is plainly shown in the case of *Opuntia lindheimeri* in many favorable seasons in portions of Texas. In the vicinity of Austin, in the early spring of 1904, there were numberless young plants springing up from cattle droppings in many of the pastures. They were fully as numerous in some situations as are the seedlings of the mesquite under similar conditions in favorable seasons in the river valleys of Arizona and on the plains of southern Texas.

This applies to the genus Opuntia, to which belong the prickly pears and cane cacti. The seeds of the other group are very different in character. There is no doubt that burros, which commonly feed upon the fruits of the viznaga (*Echinocactus wislizeni*), get a great deal of nourishment out of the seeds, which are very oily and easily masticated. It is interesting to note that No. 8170a (*Opuntia fulgida*) contains but little more food value in the whole fruit than is found in the pulpy portion alone, but in this sample most of the seeds were poorly developed or sterile. Other samples of fruit of the same species show an apparently greater food value.

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[a] Agricultural Gazette, New South Wales, 11: 671. 1900.

[b] Arizona Agricultural Experiment Station, Annual Report, 15: 496. 1904.

TABLE II.—*Chemical composition of the different parts of fruits of cacti.*

Number of sample.	Scientific name of cactus.	Part of fruit analyzed.	Water.	Ash.	Protein.	Fat.	Nitrogen-free extract.	Fiber.	Organic matter.
			P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
8022a	Opuntia phaeacantha	Seed	7.26	1.75	6.07	11.41	23.18	50.33	90.99
8022b	Opuntia phaeacantha	Pulp	92.50	2.09	.20	.07	4.63	.51	5.41
8162a	Opuntia spinosior	Whole fruit	77.74	2.97	1.74	1.11	11.50	4.94	19.29
8162b	Opuntia spinosior	Pulp	83.04	3.10	.55	.24	11.74	1.33	13.86
8173a	Echinocactus wislizeni.	Seed	8.59	3.09	10.92	15.46	36.59	25.37	88.31
8173b	Echinocactus wislizeni.	Pulp	94.14	.96	.63	.06	3.05	1.16	4.90
8170a	Opuntia fulgida	Whole fruit	82.84	2.70	.63	.51	11.63	1.69	14.46
8170b	Opuntia fulgida	Pulp	87.17	1.58	.47	.27	9.66	.91	11.25

It must be undertood that we have analyzed here but few fruits aside from those which are of more value for forage than they are as food for man. None of the cylindrical-jointed species and but few of the native prickly pears of the United States bear edible fruits.

A BALANCED RATION OF PRICKLY PEAR.

To determine in just what proportion cactus should be fed with other foods to produce a balanced ration, it is necessary to know the amount of digestible nutrients contained in the cactus, as well as those of the food or foods with which it is to be fed. This has been determined for most foods, but unfortunately there are as yet no such data for the cacti. It is hoped to be able soon to obtain the coefficient of digestion for *Opuntia lindheimeri*. For the present, all that can be done is to assume this digestibility coefficient to be the same as that of some food as similar in chemical composition and properties to the cacti as possible. It is somewhat difficult to secure a green fodder very similar in character to cactus, but perhaps its digestion coefficient will not be missed very far by assuming it to be the same as that of immature green corn fodder. By using the coefficient for this fodder the nutrients in *Opuntia lindheimeri* are found to be: Protein, 0.47 per cent; fat, 0.26 per cent; carbohydrates, 7.85 per cent. This being the case, cactus would have a nutritive ratio of 1:18, a ratio which according to the best authorities would prohibit its use alone for any feeding standard. The nutritive ratio for a standard ration varies from 1:4 to 1:12, depending upon the age, character, and kind of animal to be fed, as well as the object of the feeding; that is, whether it is desired to produce work, flesh, or milk.

If the object of feeding is to produce milk, a cow giving a heavy yield of milk should, according to the best authorities, be fed about 25 to 30 pounds a day of organic matter, containing from 1.8 to 2 pounds of digestible protein, from 0.4 to 0.7 pound of digestible fat, and 11 to 13 pounds of digestible carbohydrates, making a nutritive

ratio of from about 1:5.5 to 1:7. If a cow requiring a ration of this kind should eat cactus alone, it would take 160 pounds to furnish the fats and carbohydrates and an additional 240 pounds to furnish sufficient protein, and since to avoid scouring a cow should probably not be fed to exceed 50 or 60 pounds of cactus a day, it may be readily seen how impossible it would be for a milk cow to get even a one-sided ration from cactus alone.

A ration of 40 pounds of cactus with 10 pounds of wheat bran and 12 pounds of corn stover would furnish the nutrients in somewhat near the proper proportion. In a ration of this kind the cow would get 21.16 pounds of organic matter, containing 1.68 pounds of protein, 11.82 pounds of carbohydrates, and 0.49 pound of fat, which is in a ratio of 1:7.7.

If a ration is desired in which the cactus is fed with dried brewers' grain and cotton-seed meal, it could be made by feeding 60 pounds of cactus with 14 pounds of brewers' grain and 1 pound of cotton-seed meal. In this case 20.58 pounds of organic matter are fed, containing 2.85 pounds of protein, 10.38 pounds of carbohydrates, and 1 pound of fat. This ration would contain the nutrients in the ratio of 1:4.5. If this ration is considered too narrow, it could be widened to good advantage by feeding with it a small quantity of coarse, dry fodder, rather than by increasing the amount of cactus.

A balanced ration of cotton-seed meal and cactus can not be prepared, for if the meal be fed in just sufficient quantity to furnish the proteids it would necessitate the feeding of too much cactus to supply the remainder of the carbohydrates. From this it must not be inferred that a mixture of these foods would not make a desirable ration; in fact, current successful practice has demonstrated that it will. For example, a ration of prickly pear and cotton-seed meal was fed to steers for one hundred and five days in a recent experiment conducted by the Bureau of Plant Industry at Encinal, Tex., with a gain of $1\frac{3}{4}$ pounds of flesh a day at a cost of only $3\frac{1}{3}$ cents. Any ration of these two foods that would secure this gain each day would contain an excess of the proteids over an amount necessary for a balanced ration. Fortunately, however, an excess of proteids can be utilized in serving the function of the carbohydrates in the animal body, and this no doubt is what took place in the above experiment. Usually proteids are the most expensive foods for man and beast, and it is poor economy to substitute them for carbohydrates; yet such a condition is not uncommon in Texas cattle feeding, where cotton-seed meal is cheaper than other more starchy foods.

RELATIVE VALUE OF THE THREE GROUPS OF CACTI.

On account of several practical considerations the prickly pears are of much more value than either of the other two groups. They are more numerous in the wild state, they adapt themselves to cultivation more readily, make a more rapid growth, and are more readily propagated from cuttings, all of which are of vital importance in the economic use and handling of the crop. Practically all of the Mexican prickly pears are fed to stock to a greater or less extent, especially those growing where fodder is the most scarce, but there is only one cylindrical-jointed species (*Opuntia imbricata*) which is used to any appreciable extent. The experience of the writers has shown that *Cereus giganteus* is readily eaten by cattle when chopped up, but they know of no actual feeding having been conducted with it on any commercial scale. Mr. C. R. Orcutt states that *Echinocactus orcuttii*, which is typical of a considerable group of species, is occasionally fed in Lower California. It is only in rare instances, however, that any great quantity of feed can be secured from cacti, outside of the genus Opuntia, and the greater part of the feed in this genus is produced by the flat-jointed forms. There are about five species in the cylindrical-jointed group which have been fed with some success. *Opuntia imbricata*, from Mexico, has been referred to, and in various writings the use of *Opuntia arborescens*, *Opuntia spinosior*, and *Opuntia fulgida* are mentioned. To these should be added *Opuntia prolifera* from the coastal region of southern California. These species constitute, without doubt, the best of the cylindrical-jointed group, and when extent of territory covered, succulence, and ease of propagation are taken into consideration *Opuntia fulgida* and *Opuntia imbricata* are probably the most valuable of this group. *Opuntia arborescens* has a decidedly valuable characteristic in that it extends farther to the north than any of the other economic species of any of the groups, and it is fed to a considerable extent in localities from southern Colorado southward.

The use of these species, however, and, in fact, the extended use of nearly all the native species of this country and Mexico, presupposes artificial preparation. In dry seasons in southern Arizona, cattle feed upon the pendent bunches of fruits of the cholla (*Opuntia fulgida*), but it is done at a great sacrifice of comfort. The Texas pear (*Opuntia lindheimeri*) is grazed to a considerable extent by cattle, sheep, and goats without any preparation whatever, and even such thorny forms as cardon, shown in Plate I, are grazed by cattle in extreme cases.[a]

[a] For further discussion, see Bulletin 74 of the Bureau of Plant Industry.

NOPAL CARDON (OPUNTIA STREPTACANTHA LEHM.), THE MOST IMPORTANT OF THE MEXICAN PRICKLY PEARS.

COMMON AND SCIENTIFIC NAMES.

Considerable attention has been given to the popular names by which the various species are designated, especially the larger Mexican forms, but inasmuch as these are to be more fully considered in another publication now in process of preparation a full discussion of the subject is postponed.

The chaotic condition of the scientific literature and the general imperfection of knowledge of prickly-pear forms have rendered it very difficult to properly name the species discussed. The purpose of the writers has been to present the exact status of their information, indicating a doubt wherever one occurs. The Engelmann species, which are largely United States forms, are comparatively easily determined, in most cases through a reference to the types in the herbarium of the Missouri Botanical Garden. In case of long-established species, however, it is absolutely impossible to correlate the specimens with the literature and determine what name belongs to the plant under discussion. *Opuntia tuna*, for instance, has been paraded in literature a great deal, and to it has been assigned all sorts of species; but, as pointed out by Berger and Maiden especially, no one knows what the species is, and the writers know of no way by which its identity can ever be determined.

Some species are referred to their proper genera only. Others are given common names besides, but the majority of them are given scientific names. All species receiving chemical analyses are represented in our collections by specimens mounted upon sheets in the ordinary way or put up in boxes or in liquid. Many are growing in conservatories or upon one of the plantations maintained by the United States Department of Agriculture, while the seeds of many species have been widely distributed to those interested in the scientific and economic study of the group. The work is therefore well supported by specimens to which access will be had in completing in the future such naming as has not hitherto been undertaken. It was early recognized that good dry specimens were absolutely necessary for this work in order to make the chemical analyses and determinations of permanent value.

Whenever a sample or set of samples represents a striking or constant variation it is treated separately in the text; consequently *Opuntia lindheimeri*, for instance, appears several times under two or more headings. Each number or group of numbers is accompanied by a brief set of notes made in the field beside the plant when the samples were collected, elaborated and perfected by subsequent experience. These are presented as field notes simply and not as full technical descriptions. This rather full set of notes, popular and scientific names, and, as a final resort, our specimens and photographs, will make it possible to easily verify the determinations of the writers.

CLIMATIC REQUIREMENTS OF PRICKLY PEARS.

Prickly pears and other cacti are apparently inseparably connected in the public mind with drought and heat, but this conception of the requirements for their best development is far from perfect. Our driest deserts produce none of these plants in economic quantities, and the same is true of our hottest regions. Rather than say they are adapted to conditions of extreme heat and drought, it should be said that they thrive best in a region which has an equable temperature and a considerable rainfall periodically distributed. There is certainly no region in the world where these plants grow naturally in such profusion as they do upon the plateau of Mexico, but this is not a hot country; neither is it excessively dry. It is very dry during a large part of the year. It is a desert as compared with eastern Texas, for instance, but it has a considerable rainfall during an average year. The rain falls mostly in the summer, and then the country looks like anything but a desert. The average rainfall at Zacatecas for the past ten years, as stated by Mr. Albert L. de Lautreppe, who has made a special study of the weather records of that city in connection with a business venture, is 31½ inches, but the average for the seasons from January to April and from October to December is only five-eighths of an inch to 2⅛ inches, while the average for the other months of the year is 3½ to 7⅛ inches a month. June, July, and August are the rainy months, having an average rainfall of 4¼ to 7⅛ inches each for the past ten years.

While many species appear to be able to withstand high temperatures, they develop naturally in the greatest profusion where the heat is not excessive. The plateau of Mexico is a region with comparatively equable climate. Some species thrive under extremes of heat. *Opuntia lindheimeri* is at home in the lower Rio Grande Valley of Texas and Chihuahua, and the closely related *Opuntia engelmanni* and *Opuntia engelmanni cycloides* thrive in southern Arizona, where the mercury often reaches 111° F. On the other hand, there are species which grow where the winter temperatures go to at least –40° F., but the plants are small and of no economic importance in themselves except as they may be used to give a hardy character to more valuable species. The valuable species of the Mexican highlands thrive where the temperature falls to 14° F. in very rare instances. Usually the freezing point is only rarely reached here. During the past winter (1905–6) the mercury dropped at the city of Zacatecas to 14° F., and many of the more delicate spineless forms, as well as the natives, were badly injured. No pear was killed outright, but the branches were frozen down for four or more joints. These rotted and dropped off, but the old trunks survived. *Opuntia lindheimeri*, the common species of southern Texas, has been injured very severely within the memory of the present generation. It suffered some injury

during the winter of 1904–5. In the vicinity of San Antonio many of the plants drooped badly after the coldest weather, which registered a temperature of 12° F. The majority of the plants straightened up again, but in many the distal joints dropped off as the result of freezing.

THE USE OF PRICKLY PEAR IN MEXICO.

In Mexico the use of the prickly pear is much more varied than in this country. There the established plantations are guarded from animal depredations either by rude fences or hedges of some of the tall columnar species of Cereus or the more spiny opuntias. The latter are planted thickly in borders around the more nearly spineless forms, which stock eat readily.

All of the species are fed to stock indiscriminately. Whatever is available and can be spared is singed and fed to cattle. So far as observed, the durasnillo (*Opuntia leucotricha*) is preferred to all others. This is due to some extent to its small fiber content, but more especially to its abundant delicate spines, which are singed off more readily than those of other species which have fewer spines.

However, the extent of cattle feeding upon this kind of food is not so great in Mexico as one would suppose from the abundance of the material and the great extent of time during which the practice has been in vogue. The fact is that the average Mexican peon can not afford to feed to stock what he himself can use so profitably in other ways. The prickly pear is to him primarily an article of human food, and its place can not be taken by any other plant.

The young joints as well are eaten by man in Mexico, and the dried stems and joints are used for fuel. Of course, this fuel is exceedingly poor, but it serves the purpose in that land where this commodity is exceedingly scarce. The feeding of cacti to stock, therefore, is a secondary consideration. The limbs which break off and such other portions of the orchard material as can be spared without seriously jeopardizing the tuna crop, together with such wild forms as are available, are fed to cattle. On some of the large haciendas, especially those devoted to maguey culture, the feeding of pear to work oxen during the grassless season is a regular practice, but then only wild forms are used. Over a large part of the Republic, therefore, although the prickly pears are much used for forage, their principal use is as an article of human food.

THE SPECIES OF CACTI AND THEIR ANALYSES.

In all, 67 species and varieties of cacti are discussed, all of which have been analyzed chemically, some represented by as high as five samples. One hundred and eighty-seven fodder analyses and 26 complete ash analyses have been made. The following brief table will illustrate the characteristic composition of representative samples, together with an average of all the samples.

TABLE III.—*Chemical composition of representative samples of cactus plants and fruits.*

Number of sample.	Common name of cactus.	Scientific name of cactus.	Character of sample analyzed.	Formula.	Green.								Air dry.							
					Spines.	Water.	Ash.	Crude protein.	Crude fat.	Nitrogen-free extract.	Crude fiber.	Organic matter.	Spines.	Water.	Ash.	Crude protein.	Crude fat.	Nitrogen-free extract.	Crude fiber.	Organic matter.
					P.ct.	*P.ct.*	*P.ct.*	*P.ct.*	*P.ct.*	*P.ct.*	*P.ct.*	*P.ct.*	*P.ct.*	*P.ct.*	*P.ct.*	*P.ct.*	*P.ct.*	*P.ct.*	*P.ct.*	*P.ct.*
6329	Nopal, prickly pear.	Opuntia lindheimeri.	Last year's growth mostly.	(5-0-0-0-0)4	0.76	80.72	4.44	1.38	0.42	10.87	2.17	14.84	3.73	5.33	21.78	6.79	2.08	53.37	10.65	72.89
7571	do	do	Terminal joints	(4-0-0-0-0)3	Few.	88.64	1.64	.55	.29	7.72	1.16	9.72	Few.	7.03	13.40	4.49	2.40	63.15	9.53	79.57
6330	do	do	From old stems		.58	77.95	5.81	.92	.41	11.58	3.33	16.24	2.51	5.14	25.00	3.94	1.78	49.81	14.33	69.86
7572	do	do	do	(0-0-0-0-1-1-1)3	Few.	84.49	2.42	.36	.27	8.80	3.65	13.08	Few.	6.35	14.60	2.19	1.65	53.18	22.03	79.05
6542	do	do	Early-maturing fruits.		Few.	92.19	1.09	.65	.49	2.85	2.73	6.72	Few.	4.85	13.23	7.88	5.95	34.89	33.20	81.92
6530	Nopal tapon	Opuntia robusta.	Joints 1-3 years old.	(2-2-1)5	.71	89.62	2.95	.63	.23	4.81	1.76	7.43	6.43	5.68	26.81	5.70	2.13	43.70	15.98	67.51
7590	do	do	Joints 1-5 years old.	(1-0-1-0-1)3	.25	89.62	1.93	.46	.18	5.98	1.83	8.45	2.33	4.55	17.79	4.27	1.64	54.95	16.80	77.66
6529	do	do	Partly mature fruit		Few.	88.59	1.29	1.06	1.13	3.84	4.09	10.12	Few.	5.41	10.70	8.76	9.38	31.80	33.95	83.89
6531	do	do	Mature fruit		Few.	96.81	.26	.23	.23	1.80	.67	2.93	Few.	6.38	7.65	6.79	6.76	52.72	19.70	85.97
6254	Cholla	Opuntia fulgida.	Joints 3-4 years old.	(0-0-6-1)	1.78	72.63	3.88	.95	.43	20.39	1.72	23.49	6.13	5.60	13.40	3.29	1.48	70.27	5.96	81.00
6255	do	do	Joints 1-2 years old.	(6-6)	2.27	78.03	3.36	1.30	.35	15.37	1.59	18.61	9.60	6.95	14.25	5.48	1.48	65.09	6.75	78.80
7802	do	do	Joints 4-6 years old.	(2-3-2)7	1.72	81.51	2.21	.96	.28	14.21	.83	16.28	8.64	7.10	11.10	4.82	1.41	71.41	4.16	81.80
7796	do	do	do	(0-0-0-1-2-1)3	.94	70.33	2.73	.95	.43	17.99	7.56	26.94	2.96	6.19	8.63	3.00	1.36	56.92	23.90	85.18
6253	do	do	Fruit		Few.	83.48	2.79	.59	.36	11.18	1.60	13.73	Few.	4.88	16.05	3.39	2.09	64.36	9.23	79.07
7801	do	do	Fruit 1-6 years old		Few.	80.29	3.25	.56	.47	13.77	1.66	16.46	Few.	5.43	15.60	2.70	2.24	66.05	7.98	78.97
8170a	do	do	Fruit, largely sterile		Few.	82.84	2.70	.63	.51	11.63	1.69	14.46	Few.	5.16	14.99	3.59	2.85	64.12	9.38	79.85
8170b	do	do	Fruit, largely without seed		Few.	87.17	1.58	.47	.27	9.60	.91	11.25	Few.	4.55	11.73	3.50	1.98	71.49	6.75	83.72
6561	Sewarah	Cereus giganteus	Mature fruit		Few.	91.62	.98	1.05	.61	3.64	2.10	7.40	Few.	5.88	11.05	11.83	6.86	40.73	23.65	83.07
6699	do	do	4 sections of stem		.92	87.31	2.20	.81	.17	8.07	1.44	10.49	6.63	8.98	15.75	5.80	1.20	57.92	10.35	75.27
7805	do	do	3 sections of stem		.28	92.36	1.30	.67	.16	4.45	1.06	6.34	3.41	5.80	15.98	8.28	1.94	54.95	13.05	78.22
	Average of all prickly pears analyzed				.44	84.26	3.06	.73	.34	9.04	2.41	12.53	2.53	5.89	18.25	4.61	2.24	54.26	14.77	75.86
	Average of all cane cacti analyzed				.79	78.47	3.61	1.41	.63	12.30	3.59	17.93	3.32	6.15	15.50	6.09	2.77	54.32	15.17	78.35
	Average of all miscellaneous group analyzed				1.03	87.88	1.67	1.05	.41	7.22	1.76	10.45	8.62	6.53	13.54	8.19	2.84	54.96	13.63	79.93

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A SUCCESSFUL DAIRY FARM.[a]

By L. G. Dodge, *Scientific Assistant, Farm Management Investigations.*

INTRODUCTION.

In Delaware County, N. Y., is a farm of 200 acres, owned by John T. McDonald and managed by him as a dairy farm. About half of the land is meadow and half is permanent pasture. A small portion of the meadow is each year plowed up for other crops—a few acres of corn for soiling and a few acres of peas and oats for hay. This farm lies in the valley of a tributary of the Delaware River and extends up the hills on either side, so that the tillage land is gently rolling, while the pasture is comparatively steep. The soil is a reddish brown loam, originally filled with fragments of shale rock. The dwelling house, barn, and dairy are located on the highway at a little distance from the creek, and the mill and tenant houses near the road crossing the creek. (Pl. I, fig. 1.) The water supply is abundant, coming from several springs nearly 100 feet higher than the buildings. The shipping point is 5½ miles distant, over an easy road.

The dwelling house of the owner is provided with good plumbing, is well heated, and is lighted by electricity. The barn contains 124 cow stalls on the main floor and has a manure cellar below. The second floor can be driven upon also, and has six horse stalls and a grain room, while most of the remainder is used as a hay loft. The dairy building adjoins the barn and is equipped with steam power and the necessary machinery for butter making. A small mill for sawing and planing and for grinding grain is run by water power from the brook. In this building is a small dynamo, also run by water power, which furnishes light for all the buildings, including the cow and horse stables, the dairy building, and the three small houses for the farm

[a] This article is one of a series issued by the Bureau of Plant Industry giving the results of the study of systems of management on successful farms of various types. The cropping system on the farm here described is unique, in that half the land is in permanent pasture and half in nearly permanent meadow. Each year a few acres of the meadow that seem most to need resetting are broken up, sown to peas and oats with which grasses and clovers are seeded, or planted to corn for soiling, this to be followed by peas and oats with grasses and clovers. The special lesson to be learned from this farmer's practice is the method of managing permanent grass land to maintain its productivity.—W. J. Spillman, *Agriculturist in Charge of Farm Management Investigations.*

hands, as well as the owner's residence. There are also a small tool shed and hay barn near the large barn and a tool shed near the mill.

The farm supports about 100 head of milch cows, 25 head of young stock, 600 hens, 5 horses, and 3 or 4 hogs. Eight hired men are employed the year round. More cows are in milk in winter than in summer and the extra work in the dairy compensates for the decreased field work in winter.

The equipment of implements, tools, machinery, etc., is as follows: Two plows of the swivel type (hillside plows); 2 harrows; 1 manure spreader; 1 grain drill; 1 6-foot mower; 2 hay rakes (1 one-horse, 1 two-horse); 1 tedder (one or two horse); 2 wagons, with hay racks and brake; 1 express wagon; 1 set of ice tools; dairy equipment; saw and grist mill equipment; dynamo and lights; 1 incubator.

The land is not divided by fences into small lots, but is inclosed entirely by a stone wall, which was built when clearing the land of stone, for all the land was formerly as stony as the pastures now are. (See Pl. I, fig. 2.) Some of the tillage land has been drained with stone underdrains, and from a good deal of it there has been a great number of old pine stumps pulled out.

THE ROTATION FOLLOWED.

The rotation on this farm, if such it may be called, is exceedingly simple. Broadly speaking, half the land is in permanent pasture and half in meadow. Most of the 100 acres of meadow land is in grass and clover. Each year about 12 to 15 acres of this grass that seem most to need renewing are broken up. Of this, 2 or 3 acres are devoted to corn for green feed in late summer, to be followed by peas and oats the next spring. The remaining 10 to 12 acres are sown at once to peas and oats for hay. In each of these cases grass and clover are sown with the peas and oats, the land thus being returned to semi-permanent meadow. If the seeding fails, it is repeated after the peas and oats are cut for hay. This gives a long period during which the land stays in grass, but owing to the fact that the owner spreads the manure from more than a hundred head of live stock upon this land, hauling it at nearly all seasons of the year, midwinter and haying time excepted, the fields are kept in such a productive condition as to cut an average of 2 tons of hay per acre over the entire meadow area, including the peas and oats.

As soon as the ground is hard enough to drive over in the spring, the manure is brushed with a brush harrow, the man who drives the harrow sowing at the same time a very light application of clover seed—so light, in fact, that 1 bushel of red clover and 1 bushel of alsike mixed go over the greater part of the 100 acres. Or, when manure is being spread in the spring, some clover seed is applied by sprinkling about a cupful on top of the loaded manure spreader. This plan

FIG. 1.—VIEW ACROSS THE LOWER END OF THE MCDONALD FARM, SHOWING THE BUILDINGS, THE DWELLING HOUSE BEING PARTIALLY CONCEALED IN THE TREES.

FIG. 2.—VIEW ACROSS THE UPPER END OF THE FARM, SHOWING THE STONY NATURE OF THE LAND IN THE PASTURE, THE PRESENT CONDITION OF THE HAY LAND, AND THE LOCATION OF THE MILL POND.

provides for renewal of the clover and, through the agency of the clover and manure, maintains a better condition of the other grasses. The owner believes also that the seedling plants of the clover hold better through an unfavorable winter in the sod than they would in a newly fitted seed bed. The manure is applied, so far as possible, with a spreader.

Oats and peas are seeded at the rate of 2 bushels of oats and 1 of peas per acre; with these 6 quarts each of timothy and clover per acre are sown, the drill with which the grain is sown being provided with a grass-seed attachment. Then if the oats lodge or the season is unfavorable, so that the grass is killed out, a new application of seed is made as soon as the oats and peas are cut, and the seed worked in with a brush harrow. Following this a light coating of manure is put on with the spreader. If the field should come in full of weeds it would be replowed before seeding, but in any case the owner's plan is to get a stand of grass as soon as possible, that being his best crop.

HARVESTING THE HAY.

Since hay is the principal crop on this farm, it is worth while to consider the method employed in putting in the hay and the utilization of labor at that work. On the first day of hay harvest one man runs the mower in the forenoon; another man runs the tedder in the forenoon and the rake in the afternoon. Late in the afternoon one or more men begin cocking the raked hay.

In the forenoon of the second and later days one man with a team runs the mower, another the tedder, and four men spread out the hay cocked the previous afternoon in order that it may dry. In the afternoons two men and teams haul hay from the field to the barn. The proprietor works the hay fork on the loaded wagon, two men distribute the hay in the mow, two pitch hay in the field, one rakes the hay cut and tedded in the forenoon, and another cocks the raked hay. The man last mentioned also finds time to feed the hens in the afternoon.

One of the hands spends his whole time in the dairy. Another man is engaged in the dairy in the forenoons for a local dairy company whose milk is handled in Mr. McDonald's building, while in the afternoons this man works for Mr. McDonald in the hayfields or wherever needed. Consequently in the forenoons there are eight men besides the proprietor at work, and in the afternoons nine men are working on the farm.

During forenoons in hay harvest the proprietor spends his time grinding sickles and in superintending the work of his men so as to keep them all profitably employed.

From 5 to 6 o'clock in the afternoon most of the men are kept busy milking. Those who handle the work teams, however, have

their teams to care for, and, during hay harvest, one of these is back in the field shortly after 5.30 and both wagons are loaded and drawn in before 6.15 o'clock. The lighter team is hitched to the two-horse rake at 6 o'clock and rakes until 7.30. The men who milk, after getting their supper go to the field for a short time to bunch up hay or load the two wagons. This makes a long day for the men, but this extra labor is required for only a short time in the busy part of the haying season; at other seasons the normal day's work ends at 6 o'clock.

Two days in the week the butter and eggs must be delivered to the station, so instead of both teams going into the field on these days one man with the lighter team starts about 7.30 o'clock a. m. for town, returning before noon. On the day that the writer watched operations closely the other team began drawing hay shortly after 8 o'clock and had in two loads by 10.30. Of twelve loads brought in during the writer's visit, two were weighed. One had 2,400 pounds of hay on it, the other 2,900. It is reasonably certain that the average was at least 2,500 pounds and all were taken off an area of not more than 5 acres, most of which had not been plowed for fifteen years. This shows a yield of approximately 3 tons to the acre and was made up wholly of fine grasses with clover mixed in, a most excellent quality of dairy feed. The teams which do this work are of good size. One pair of mares weighs 2,700 pounds, the other pair, horses, 2,860 pounds. The single rake was drawn during the afternoon by the driving horse, considerably lighter in weight.

As soon after haying as there is sufficient aftermath to furnish feed the cows are turned into the meadows, for the permanent pasture is then getting dry. Any newly seeded piece, however, is previously given a light coat of manure, which prevents the cows from grazing it down, and any other piece which would be hurt by grazing is treated likewise. The cornfield is shut off with a temporary wire fence. Some manure is spread occasionally even on the permanent pasture.

FEED FOR THE COWS AND CALVES.

As soon as the pasture gets dry and insufficient in the summer, and before the mowing land can be used, a suitable quantity of hay is fed to the cows every day, and later on the corn is fed out green. The roughage for winter feed is entirely of this mixed hay, which contains a large proportion of clover. The cows get, when in full milk, 8 pounds of grain a day, in two feeds. The grain is mixed, consisting of 1 part cotton seed meal, 2 parts ground corn, 2 parts ground oats, and 4 parts wheat bran. Skim milk is fed to the calves until they are more than a year old, and the surplus at all times is given to the milch cows.

BUTTER PRODUCTION.

The cows freshen during the fall, so that most of the butter is produced in the winter; fresh pasture comes on at such a time in the period of lactation as to prolong the flow of milk in the spring. The cows produce on an average a pound of butter each per day for three hundred days in the year—that is, 30,000 pounds of butter from 100 cows in the course of a year. The butter is sold as soon as made the year round to regular customers, mainly in New York City. The selling price is 35 cents, Mr. McDonald paying the express charges to the city. By the use of plenty of hay and skim milk for the calves as they grow up they are kept in vigorous shape and breed rather earlier than the average, so that many of the heifers are in milk at two years of age.

POULTRY PRODUCTION.

Four hundred of the 600 hens kept on the farm are housed in one long, cheaply constructed house. This house is divided so that approximately 50 hens are in each inclosure. The other 200 hens for breeding stock are kept in smaller pens in a separate location.

RESULTS ACHIEVED.

The gross receipts for a year for butter, eggs, and poultry, with occasionally a small quantity of hay sold, amount to $10,000 in round numbers. The annual expenses for grain are approximately $3,000; for labor, another $3,000. The debt on this farm in 1875 is said to have been $8,400, and to have been entirely cleared up in the twelve years following that date. The hay land has been cleared of stumps and stones, the buildings improved and added to (the dwelling house, barn, and dairy now having slate roofs), the mill and electric-light equipment have been put in, and the land rendered vastly more productive than it was in 1875.

The orchard back of the house has been made more productive by general care, and especially by burying on the up-hill side of an apple tree any animal which died on the farm.

In spite of the simplicity of its cropping system, this farm has been rendered so productive as to provide many of the comforts and conveniences usually attributed to city life, and to maintain a large family at the same time.

B. P. I.—245.

PLANNING A CROPPING SYSTEM.

By W. J. Spillman, *Agriculturist in Charge of Farm Management Investigations.*

INTRODUCTION.

One of the lines of work undertaken by the Office of Farm Management Investigations is the making of working plans for farms. Some of these plans are more or less general in character, representing systems adapted to particular types of farms in definite soil and climatic areas. Others are made for individual farms.

There are two principal reasons why work of this kind is undertaken. In the first place, very few farms have any definite cropping system, and it is comparatively easy to plan a system that will meet the requirements of the case and increase the farmer's income. We are thus able to render material service to a considerable number of farmers, whose farms in consequence become centers of local interest and serve as object lessons to the community. In the second place, the number of farms on which the full possibilities of a given type of farming are realized is exceedingly small; so small, in fact, that it is necessary to increase the number very materially before many important problems relating to farm management can be solved.

To illustrate: On the farm of Mr. W. H. Rowe, described in Farmers' Bulletin No. 272,[a] the possibilities of a given system of managing swine with a particular cropping system have been worked out. One litter of pigs a year is produced. These are pastured on clover in summer and fed sufficient grain to bring them to a weight of from 100 to 125 pounds by the end of the pasture season. In winter they are fed grain and soy bean hay. The next summer they return to the clover pasture, while the feeding of grain continues. About the 1st of August they are sold, weighing from 325 to 350 pounds each. This system utilizes the full possibilities of the clover pasture. The extra hogs during early summer consume the abundant growth of clover at that season, while the smaller number later find just about the amount of pasture they can utilize. With this system the farmer is able to sell an average of six large hogs a year for each acre in clover on the farm. This farm is in the North, where winter pasture is not available. The owner knew just what acreage of each crop to grow, and he knew approximately the quantity of grain and mill feed he would need during the year. This is the only instance thus far found in which a farm devoted to hog raising had its problems so fully worked out.

[a] A Successful Hog and Seed-Corn Farm, 1906.

Suppose, now, a hog farm is located far enough south to make winter pasture available, and that it is desired to produce 200-pound hogs. Fall litters of pigs may be given pasture and grain during winter and early summer, the grain being so apportioned as to cause the hogs to reach the desired weight, say, by the 1st of July. Spring litters may be given pasture and grain till autumn, and then penned and forced rapidly to a weight of 200 pounds. In such a system, on a farm of a given size, what acreage of winter pasture and of summer pasture should be provided? What pasture crops should be used? How much grain should be fed? These are questions that can only be answered by experience. We are able to make estimates that will serve as approximate answers, but the experience of a considerable number of farms is necessary before these estimates can be relied on.

There are similar questions that need to be worked out in connection with nearly every type of farming for every section of the United States. One of the most important reasons why detailed plans are drawn in this office for individual farms is, therefore, to enable us to find valuable material for the study of the possibilities of the various types of farming. Among a large number of plans furnished, some will result in the development of farms to their full possibilities. Every such farm is an object lesson of great value. A large number of such farms would furnish data for generalizations of inestimable value.

The number of distinct types of farming is large, and most farms combine two or more of these types. Even farms of exactly the same type—as, for instance, dairy farms that grow only roughage and buy all the concentrates—may and do have widely different cropping systems. This is true even on contiguous farms of the same type. This field of research is therefore a wide one. It relates in a most vital way to the development of the agricultural resources of the country. If properly pursued it can not fail to result in the accumulation of a vast number of important facts and principles which can be put into pedagogical form and thus become an important subject of instruction in schools.

In attempting to plan a cropping system to fit exactly the needs of a farm, the objection may be raised that this is impossible because of the great seasonal variation in yields. This objection overlooks the fact that every farmer in the United States is actually compelled to make such plans every year, whether they are feasible or not. There can be no two answers to the question whether we shall attempt to aid the farmer in this the most important work he has to do. If agricultural science is of any value at all it must aid the farmer in planning his work. With sufficient study, the ordinary fluctuations in yields become known quantities, and allowances can be made for them. When a farm is heavily stocked, it will occasionally occur

that feed will run short. In such cases the only resource is to buy, unless the farmer is willing to dispense with a portion of his stock. It should be remembered that when a farmer is buying feed he is also buying fertility. One of the most successful farmers in this country says: "I usually keep enough stock to eat all I raise, and I usually take the chance of keeping a little more; for it does the farm no harm to buy a little feed if it is needed."

FARM SELECTED TO ILLUSTRATE THE METHODS USED IN PLANNING A CROPPING SYSTEM.

The plan selected to illustrate the methods used in arranging a cropping system to fit definite conditions is one recently drawn for a farm in northern Illinois. The manager had already determined approximately the possibilities of this farm under the particular type of farming he desired to follow. The number of conditions to be met was unusually large. Figure 1 shows the arrangement of the farm as it was presented to us. It will be seen that the arable land aggregates 103 acres. This is all good land, sloping in a fairly uniform manner to the south and west, sufficiently for drainage purposes. It was desired to keep about 25 cows, 5 to 15 head of horses (some of these to be kept for city owners), 50 to 60 hogs, and 100 hens. It was desired that a farmstead be reserved in the northwest corner of the arable portion.

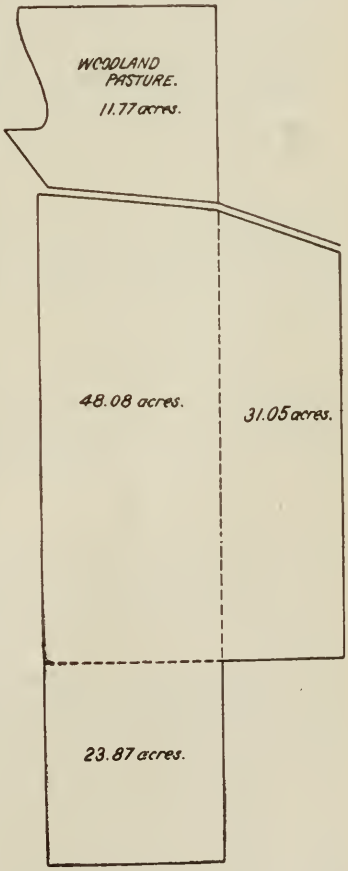

FIG. 1.—Plan of farm as submitted by the manager for the recommendation of a suitable cropping system.

It was preferred that all the stock should be provided with pasture. At the outset it was plain that ordinary permanent pastures for all this stock would occupy too much land. It was therefore decided to provide more productive temporary pastures. The condition of the land justified the assumption of the following yields: Silage, 9 tons; hay, 2 tons; soiling corn, 7 tons. It was assumed that by feeding 5 pounds of hay or 20 pounds of soiling corn per head daily, the pasture could be made to carry 1 cow per acre.

In order to ascertain the quantity of feed required annually, the following system of feeding was assumed:

Cows.

May 10–October 10.—One acre of pasture per head. (This pasture will be second-year timothy and clover meadow.)

May 10–August 10.—Five pounds of hay, with pasture.

August 10–October 10.—Twenty pounds daily of soiling corn or silage with pasture.

October 10–May 10.—The average ration for dry and other cows is silage, 40 pounds; hay, 10 pounds; grain, 4 pounds.

Bulls.

May 10–August 10.—Silage, 25 pounds; hay, 15 pounds; grain, 4 pounds.

August 10–October 10.—Soiling crops, 25 pounds; hay, 15 pounds; grain, 4 pounds.

October 10–May 10.—Silage, 30 pounds; hay, 18 pounds; grain, 4 pounds.

Yearlings.

May 1–October 1.—Pasture, with 5 pounds of hay daily.

October 1–31.—Pasture, with 25 pounds of rape daily.

November 1–30.—Hay, 12 pounds, and rape, 30 pounds, daily.

December 1–April 30.—Hay, 10 pounds, and silage, 25 pounds, daily.

Calves.

First four months, an average of 15 pounds of milk, 5 pounds of hay, and 1 pound of grain daily. (This is a liberal allowance.) Five months, pasture, with 5 pounds of hay daily. One month, pasture, with 10 pounds of rape daily. Two months, hay, 9 pounds, and silage, 15 pounds, daily.

Horses.

An average of 18 pounds of hay and 6 pounds of grain daily throughout the year. This is an overestimate, since some of the horses will be at pasture part of the time, but the number of horses in winter will exceed the number in summer. Besides, it is well to have a reserve of feed in case of short crops.

Hogs.

The system of feeding hogs was assumed to be that used on the farm described in Farmers' Bulletin No. 272, already referred to. These two farms are in the same section and on soil of the same type. The Rowe system was also used, because it is the only one for which accurate data are at hand and which is adapted to the section in question.

The following table gives the number of stock and the quantity of each kind of food required, together with the yields per acre and the number of acres of each class of crops:

Number of live stock.	Silage.	Hay.	Soiling.	Grain.	Rape.	Pasture.
	Tons.	*Tons.*	*Tons.*	*Tons.*	*Acres.*	*Acres.*
25 cows	107	34	15	10.7	.....	25
2 bulls	9	6	2	1.46	.....	.....
10 horses	.....	33	.....	10.95	.....	10
13 young stock	15	15	.....	.39	0.52	.....
6 sows	.....	2	.....	35.40	.....	5
48 pigs	.....					
Total	131	90	17	58.90	.52	40
Yield to the acre	9	2	7	.....	.....	.....
Acres	14.6	45	2.43	.....	.52	40

From the preceding table it is seen that the following acreages are required: Corn, 14.6+2.43=17.03; hay, 45; pasture, 40; and rape, 0.52; a total of 102.55 acres. The problem now is to arrange these acreages into suitable rotations.

The fact that the cows need 25 acres of pasture suggests one rotation on fields of 25 acres each. A part of one of these fields may also furnish pasture for the horses. The further fact that the hogs require 5 acres of clover pasture suggests another rotation on 5-acre fields. Since the necessary acreage is practically the whole of the arable land it will be necessary to double-crop a few acres in order to secure space for the farmstead. No estimate of pasture for young stock is included in the table. Since it is desirable to keep about half as many of these as there are mature cows, in order to maintain a high degree of efficiency in the herd, it happens that the tract of 11.77 acres of woodland pasture north of the road just about suffices for the young stock.

THE ROTATIONS ADOPTED.

A careful consideration of the conditions specified and of the many different possible rotations led to the adoption of one three-year rotation as follows: First year, 7 acres of corn and 18 acres of peas and oats; second year, timothy and clover; third year, timothy and clover.

This rotation requires that timothy and clover be sown in the 7 acres of corn at the last cultivation, a common practice in New England and a successful practice on several farms in Iowa, Missouri, and other Western States. Timothy and clover are also to be sown either with the peas and oats, or immediately after the latter are harvested for hay. The third year of this rotation furnishes the necessary pasture for the cows; the second year furnishes the required 10 acres of pasture for the horses and 15 acres for hay. This will require a temporary fence, which, however, is entirely feasible.

In case the seeding of grass fails, rye may be sown after the corn in the fall, to be followed by soy beans for hay the next summer. If the seeding of grass after the peas and oats fails, winter wheat should be sown on the land needed for horse pasture. This will furnish good pasture throughout the summer, as the wheat will not stool until late in the fall or early the next spring. The remainder of the pea and oat land may very properly be planted to sorghum for hay. The next year the whole 25 acres may be sown in winter wheat in the spring, to be used by the cows for pasture during the summer.

To secure the 5 acres of clover for the hogs, in a rotation in which the remaining crops are useful, the following three-year rotation was arranged: First year, corn, in which clover is sown at the last cultivation; second year, clover; third year, peas and oats for hay, followed by rape sown in midsummer.

This rotation permits more rape to be grown than is strictly needed, but the extra quantity can be utilized by the pigs and calves.

If the seeding of clover in the corn fails, sow winter wheat in half of it in the autumn. Pasture this wheat down the next spring, and follow it by sorghum for hog pasture, turning the hogs in on the sorghum when it is about 18 inches high. The other half of the land should be planted to winter wheat in the spring. This will furnish good pasture for hogs throughout the summer.

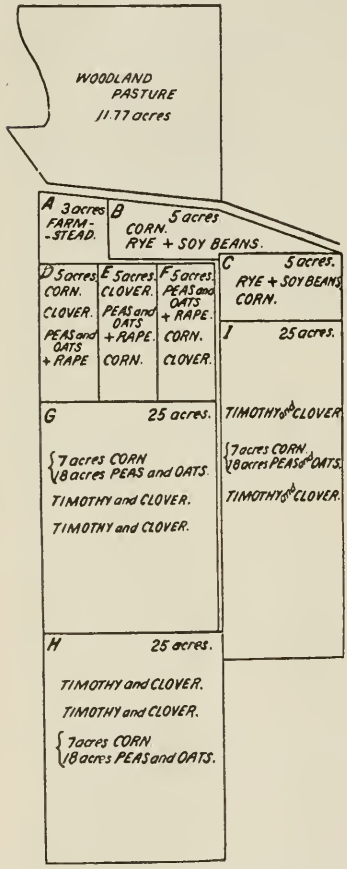

FIG. 2.—Final arrangement of the several fields, showing the cropping system recommended.

These two rotations occupy 90 acres of land, and furnish 12 acres of corn, 38 acres of hay, 5 acres of rape, and all the pasture needed. There are still needed 5 acres of corn and 7 acres of hay. Reserving 3 acres for the farmstead, 10 acres on which to grow these crops are left. The evident solution of this problem lies in a two-field rotation of corn, 5 acres, followed by a double crop of hay the next year. Fortunately, the farm described in Farmers' Bulletin No. 272 has shown that soy beans are not only an excellent hay crop in that section, but that they may be planted as late as the last week in June. This fact suggests rye as a winter hay crop. Only 2 acres of this need be used for hay, since only 7 acres of hay are needed and the soy beans furnish 5 acres. The remaining 3 acres of rye will be convenient for bedding. Accordingly, the following two-year rotation was laid out for two 5-acre fields: First year, corn, followed by fall-sown rye; second year, rye, followed by soy beans.

It now remains to fit these three rotations into the arable land. Figure 2 shows the final result. This arrangement permits a single road to reach every field on the farm. The peculiar outline of the farm makes this road rather long, but it would be hard to avoid this slight difficulty.

Fields G, H, and I, figure 2, are to be devoted to the three-year rotation consisting of 7 acres of corn and 18 acres of peas and oats the first

year, followed by timothy and clover left down two years. The other three-year rotation on 5-acre fields may be run on any three of the fields B, C, D, E, and F, with the two-year rotation on the remaining two. The farmstead occupies the 3 acres in subdivision A. This gives room for a tenant house, barn, chicken house, and a small garden.

On receiving the above plans, the manager of this farm wrote: "I have carefully read your suggestions as to the field arrangements of the farm and the plan of operation. I do not see why I can not carry out every suggestion to the letter."

The results of the operation of this plan will be carefully studied by this office. It will be seen that some features of the plan are somewhat experimental, at least for that locality. Other features are based on successful practice on near-by farms.

ARRANGEMENT OF CROPPING SYSTEMS FOR FARMS.

It is hoped that ultimately it will be possible by the study of farm practice on the best farms to arrange rotations in all parts of the country based entirely on successful local practice. While this office can not undertake to furnish detailed plans for an indefinite number of individual farms, at the same time we desire the opportunity to do a considerable amount of this work, in order that we may test the possibilities of certain types of farming and enlarge the number of highly successful farms, so that we may have more material for the study of farm management. Ultimately it is hoped to formulate generalized plans for farms of various types in all sections of the country, and to make these plans available in our publications.

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B. P. I.—246.

THE APPLICATION OF VEGETATIVE PROPAGATION TO LEGUMINOUS FORAGE PLANTS.[a]

By J. M. Westgate, *Assistant Agrostologist in Charge of Alfalfa and Clover Introduction, Forage Crop Investigations*, and George W. Oliver, *Plant Propagator, Seed and Plant Introduction Investigations.*

INTRODUCTION.

The practical difficulties which have presented themselves in connection with the development of improved strains of perennial forage plants have been such as to retard the progress of the work. The necessity for isolation to prevent promiscuous pollination and the time required to secure any considerable quantity of seed have together served to handicap seriously the work of developing new strains of forage plants, especially the perennial legumes. The method of propagating forage plants by means of cuttings herein described has been worked out chiefly in connection with *Medicago sativa* and *Trifolium pratense*, but preliminary experiments indicate that it may be quite as successfully adapted to all dicotyledonous forage plants. Among the species which have been successfully propagated in this manner may be mentioned *Medicago sativa*, *Melilotus officinalis*, *M. alba*, *Trifolium pratense*, and *T. repens*. By using the offsets or innovations the method is also applicable to grasses.

A number of problems in connection with the self-sterility of the different species in question demand further attention. It is hoped that the method here suggested will stimulate the work of developing varieties of forage crops throughout the country.

[a] In the summer of 1903 a plot of Peruvian alfalfa (S. P. I. No. 9303) in the grass garden of the Department of Agriculture proved resistant to the leaf-spot disease (*Pseudopeziza medicaginis*), which nearly ruined the check plot of ordinary alfalfa. Although this strain is nonhardy and ordinarily winterkills except in the southern portions of the United States, there were two plants which survived the severe winter of 1903–4 in Washington, D. C. These points, together with the hairiness, leafiness, and vigorous growth of this variety, brought it to the attention of those interested in breeding alfalfa. These plants were placed in large pots and moved to the greenhouse to be utilized in the hybridization work inaugurated by Dr. B. T. Galloway. Later on Doctor Galloway conceived the idea of raising a large number of plants of these two individuals vegetatively, in order to produce a large quantity of seeds the same season. This was successfully accomplished by the method here described. The adaptation of this method to the breeding of forage crops, especially the legumes, has proved so promising that it is deemed advisable to publish the results obtained.—C. V. Piper, *Agrostologist in Charge of Forage Crop Investigations.*

DESCRIPTION OF THE METHOD EMPLOYED IN THE VEGETATIVE PROPAGATION OF LEGUMINOUS PLANTS.

The method, as here described, applies specifically to alfalfa. Slight modifications may be necessary in case of its application to other species.

The cuttings should be made about three inches in length, preferably from the upper portion of reasonably matured stems. Plants grown outside the greenhouse produce the best cuttings, but in case the stock plants are not near at hand it is generally advisable to transplant them to the greenhouse, cutting the stems back close to the ground. Such plants will give an abundance of good material for cuttings within two weeks. It is practicable, when the cutting material is limited in quantity, to utilize also the middle and lower portions of the stem. In any case, two or three nodes should be included in each cutting, the lower being near the base to facilitate rooting. It is possible to secure a second set of cuttings from the original ones when they have grown to twice their original height, usually about three weeks after potting. The upper cuttings of the original stem are best adapted to this second series of cuttings, as the terminal growth is not interrupted. (Pl. I, fig. 1.)

The slips should be inserted in sand (Pl. I, fig. 2) and when the largest roots are three-fourths of an inch in length they should be transferred to 2-inch pots, and later on to 3-inch pots. (Pl. II, fig. 1.) The size which the plants can attain in such pots without becoming pot-bound will permit them to be transplanted to the permanent nursery rows, if the season be suitable, or to an outside cold frame (Pl. II, fig. 2), to remain dormant till spring, in case the cuttings are made during the winter. Greenhouse facilities are desirable, though not essential. It is possible with 30 square feet of greenhouse space and 90 square feet of cold frames to secure, during a single winter, 1,000 plants from an alfalfa plant of average size. In the northern portions of the United States the conditions of the weather may be too severe to permit of transfer to outside cold frames. In the southern portion of the country cold frame protection may not be necessary, but some means should be adopted to protect the plants from other sources of danger until they can be permanently transplanted.

The efficiency of the method is shown by the fact that at least 95 per cent of alfalfa cuttings become well rooted in the pots. The newly potted cuttings should be watered sparingly and shaded from direct sunlight for the first two days. Where it has been necessary to transfer the plants to cold frames at Washington, D. C., in midwinter, the loss has been as high as 10 per cent, owing to the sudden change of temperature. Cloth protection is recommended, as the plants, having been grown in the greenhouse, are likely to be tender.

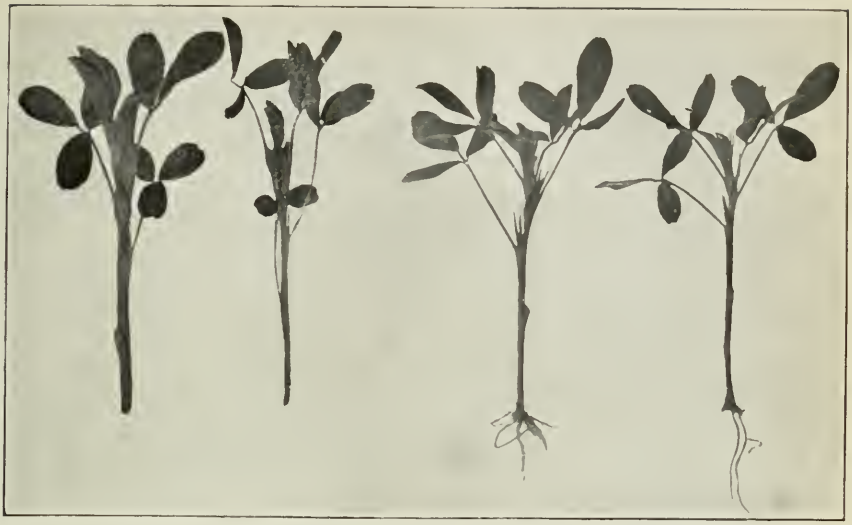

FIG. 1.—CUTTINGS OF PERUVIAN ALFALFA BEFORE AND AFTER ROOTING.

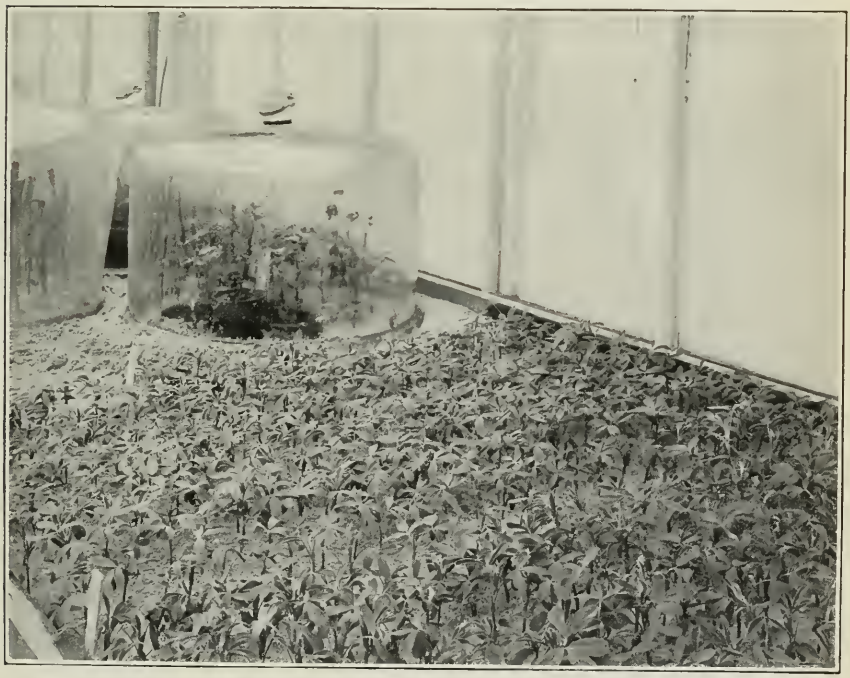

FIG. 2.—CUTTINGS OF PERUVIAN ALFALFA ROOTED IN SAND IN GREENHOUSE.

FIG. 1.—POTTED CUTTINGS OF PERUVIAN ALFALFA IN GREENHOUSE.

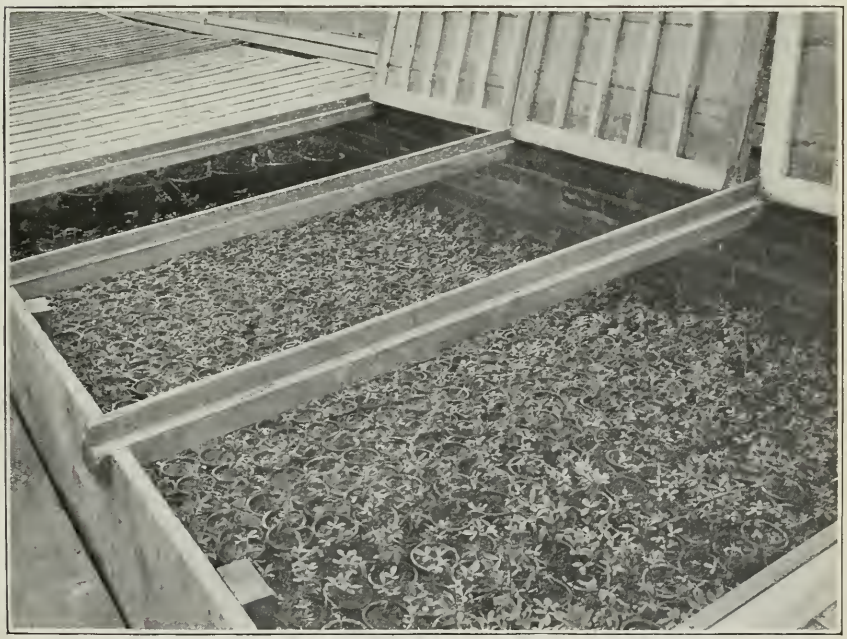

FIG. 2.—POTTED CUTTINGS OF PERUVIAN ALFALFA IN COLD FRAMES.

Bul. 102, Bureau of Plant Industry, U. S. Dept. of Agriculture.

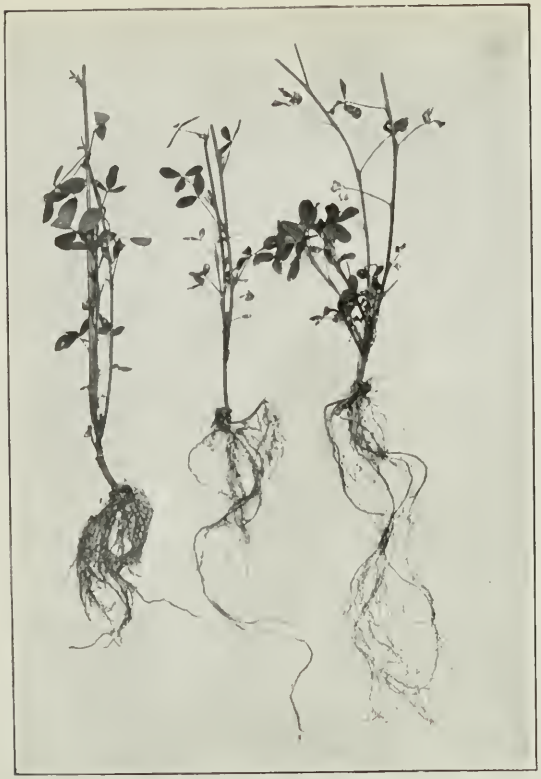

FIG. 1.—ROOTED CUTTINGS OF PERUVIAN ALFALFA READY FOR TRANSPLANTING TO PERMANENT NURSERY ROWS.

FIG. 2.—PLANTS FROM CUTTINGS OF PERUVIAN ALFALFA IN PERMANENT NURSERY ROWS.

No losses resulted on one occasion in the transfer of 1,800 plants to the permanent nursery rows 5 miles distant. The tops were cut back to 6 inches in height before being removed from the pots in the cold frames. (See Pl. III, figs. 1 and 2.)

APPLICATION OF THE METHOD TO PRACTICAL PLANT-BREEDING PROBLEMS.

In connection with establishing new varieties of such leguminous forage plants as alfalfa and clover it is sometimes desirable to start with a strain from a single individual, or at best from a limited number of individuals. This is the case where an especially promising form is confined to so few plants that the problem of increasing the stock for further tests and possible introduction is a serious one. In work of this kind many difficulties have heretofore been encountered. The seed selected from a promising set of individuals in an ordinary nursery or testing plot may have as its male parents plants of all of the strains in the series under test, a circumstance which works against the fixing of the strain along the desired lines.

This promiscuous parentage can usually be avoided only by keeping the remainder of the plants clipped to prevent flowering. This is not practicable in case other strains are being developed at the same time. While it is possible to isolate several hundred plants so that the danger of outside pollination is for the most part eliminated, yet with a few plants this is much less satisfactory, as there is not the protection of numbers which a considerable area of plants of one strain gives. The several hundred plants which can readily be produced from the selected individuals during the winter can be isolated by transfer to a considerable distance from other plants of the same or closely related species. It is possible that a considerable area could be practically isolated by lateral screens to confine the fertilizing insects temporarily to the plants in question. Under these conditions the presence of great numbers will make it probable that the bulk of the seed secured will have the selected individuals for its male parents.

The quantity of seed procurable from a few plants is usually so small that several seasons are required to obtain sufficient stock for even the preliminary tests of the new strain under field conditions. But by using cuttings it is quite practicable to produce in the greenhouse as many plants from one individual during the first winter as would be expected in at least two years from seed. Therefore this method results in a considerable shortening of the time required to get the seed of any one selected strain in sufficient quantities for field tests.

In practical selection work where strains resistant to cold, drought, or disease are being developed, natural selection will weed out the

undesirable plants. In these cases the method suggested by Hays [a] is most practicable. In case, however, the selections are being made along different lines, as for yield, leafiness, or composition, there can be no natural elimination of the undesirable individuals. Artificial elimination in many cases is tedious, as, for instance, when selection for composition is in progress. The method here described will enable fixed strains to be secured in a much shorter time than where the seed is influenced by pollen from inferior individuals.

In cases where there is at hand but a single individual of a given strain its possible destruction by accident may be guarded against by increasing the stock, as here suggested. If the preliminary tests show it to be of probable value, the question of seed production can then be considered.

The transplanting of matured alfalfa plants is difficult, owing to their great root development. It is much more expedient to make cuttings to the required number and transplant these to the desired location.

In experimental tests, such as fertilizer pot trials with single plants, it is well known that the individual variations of the different plants utilized is a varying factor, for which it is difficult to make corrections. This factor is practically eliminated where the plants under test are produced by cuttings from a single individual. It is suggested that in fertilizer tests, for instance, where pots or even small plots are used, the experiments can be rendered less liable to error by utilizing freshly rooted cuttings of a single individual for the entire series of experiments.

In view of the bearing which the self-fertility of a given species has upon the application of the method to starting a strain from a single individual, a list of self-sterile and self-fertile plants is here given. This list is from Kirchner,[b] based in part upon his own work and, in part, upon that of others. Those plants listed as self-sterile failed to set seed when the inflorescence was bagged, while the self-fertile species produced seed when similarly covered.

Self-sterile.—Medicago sativa, M. falcata, Trifolium pratense, T. hybridum, Vicia cracca, V. angustifolia, V. villosa.

Self-fertile.—Melilotus alba, Medicago carstiensis, M. denticulata, Trifolium repens (slightly), T. incarnatum (slightly), Ornithopus sativus, Cicer arietinum, Vicia sativa, V. faba, Lens esculenta, Lathyrus sativus, L. tingitanus, Pisum sativum, Glycine hispida, Phaseolus vulgaris, Vigna sinensis.

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[a] Hays, W. M. A Method of Breeding a Hardy Alfalfa. American Breeders' Association, vol. 1, 1905.

[b] Kirchner, O. Ueber die Wirkung der Selbstbestäubung bei den Papilionaceen. Naturw. Zeitschrift für Land und Forstwirthschaft, parts 1, 2, and 3, 1905. Digest in Bot. Centralbl., Vol. XCVIII, No. 18, p. 449, 1905.

The behavior of any species under continued inbreeding will determine the minimum number of plants which can be utilized as the foundation stock for a given strain. It is, of course, impossible to start with a single individual in case it is absolutely sterile to its own pollen. It may be, however, that the differentiation incident to vegetative propagation permits the use of pollen of plants derived from the same individual. If this last condition does not obtain, the employment of at least two individuals is essential. These should, of course, be as nearly identical as possible with regard to the desired characteristics.

The legumes are variable in respect to self-pollination, and unfortunately there still remains a great deal of work to be done in this direction, as many of the early experiments were not performed under as rigid conditions as might be wished. It is probable that many flowers failing to set seed when bagged fail not because they are sterile to their own pollen, but because of abnormal conditions incident to the bagging. A series of experiments is in progress to determine whether a number of the species of legumes usually regarded as self-sterile are not to a certain extent self-fertile, at least to pollen from other portions of the same plant or from another plant produced from a cutting from the same individual.

B. P. I.—261.

THE CONTROL OF TEXAS ROOT-ROT OF COTTON.[a]

By C. L. Shear, *Pathologist*, and George F. Miles, *Scientific Assistant in Pathology.*

INTRODUCTION.

Root-rot, or the so-called "dying" of cotton, is each year becoming a more and more serious enemy of the cotton grower in Texas and other parts of the Southwest. It has not yet been found east of Texas, but it is likely to spread gradually eastward. The extent of its damage to the cotton crop during the past season (1906) was apparently greater than ever before. It has been estimated that the total loss caused by this disease in Texas last year was about $3,000,000. During seasons favorable to the development of the parasite it increases its area of destruction quite rapidly. Some cotton planters have expressed the opinion that this disease is at present a more serious menace to the cotton crop of Texas than the boll weevil.

Root-rot is not restricted to cotton, but attacks a large number of other cultivated and wild plants.

CAUSE OF ROOT-ROT.

The disease has been attributed by planters to a variety of causes. Our investigations have shown, however, that it is primarily due to a fungous parasite which lives and spreads in the soil. This fungus is known as a species of Ozonium and is most prevalent and injurious in the Houston clay or black waxy soils of the Southwest. Under favorable conditions of temperature and moisture, the fungus attacks the roots of the cotton plants, destroying the rootlets and external surface of the roots and also invading the fibro-vascular system, thus causing the plants to suddenly wilt and die. This organism grows best where the aeration of the soil is poorest. The disease may be easily recognized by the sudden wilting and dying of the plants and the presence on the roots of dirty yellowish strands or a thin weft of the fungous filaments.

[a] The results of the field experiments conducted by Doctor Shear and Mr. Miles last season (1906) were so promising that it is deemed desirable to present them to cotton growers at once. Further time will be required to complete the investigations and demonstrate more exactly the value of the method recommended.—B. T. Galloway, *Pathologist and Physiologist, and Chief of Bureau.*

EFFORTS TO CONTROL THE DISEASE.

Our investigation of this disease, including the tests of possible methods of prevention or control, is not yet complete. A considerable variety of tests has been made in the application of various fungicides and other chemicals and fertilizers to the soil, and attempts have also been made to secure by selection a race or variety of cotton that might be immune or show some degree of resistance to the disease. Neither of these lines of investigation has yet given promise of success.

ROTATION OF CROPS.

It is generally known to planters familiar with root-rot that it does not affect grasses and grains, and when such crops are grown upon infected land for a few years the succeeding cotton crop is not likely to suffer so badly. The beneficial results from such rotations alone are, however, not always uniform or satisfactory.

AERATION OF THE SOIL BY DEEP PLOWING.

Field and laboratory investigations, coupled with the experience of practical growers, have led the writers to conclude that lack of proper aeration of the soil is one of the most important factors favoring the development of the root-rot fungus. Deeper plowing than that usually practiced in ordinary cultivation methods improves the aeration of the soil and was therefore tried.

Three series of experiments were conducted, consisting of (1) deep fall plowing, the land being plowed to a depth of 7 to 9 inches on December 7 and 8, 1905, (2) deep spring plowing, and (3) spring subsoiling.

DEEP FALL PLOWING.

The experiment in deep fall plowing was carried on near Luling, Tex. An area was selected where the cotton was nearly all killed by the root-rot during the previous season. Three acres of this field were plowed 7 to 9 inches deep; the remainder was given the ordinary preparation and cultivation, being simply bedded up with a "middle buster" in the spring. The cotton on both plats was planted at the same time and treated in the same manner during the season. On October 25, 1906, by an actual count of the plants in 15 rows of each plat, representing the average condition, only 12 per cent of the plants on the deep-plowed plat were found to be dead, while on the check plat adjoining, which had received ordinary preparation, 96 per cent of the plants had been killed by the disease.

DEEP SPRING PLOWING AND SUBSOILING.

The results of the deep spring plowing and subsoiling were not so satisfactory, though there was a very noticeable benefit from this treatment. The plants on the subsoiled land showed much less rot than those on the land which was plowed deep. The cotton was noticeably larger and more productive on all the treated plats, and especially on that which was subsoiled.

The accompanying illustration of our experimental plat at Petty, Tex., from a photograph taken October 19, 1906, shows on the left root-rot-infected land treated by spring subsoiling and on the right

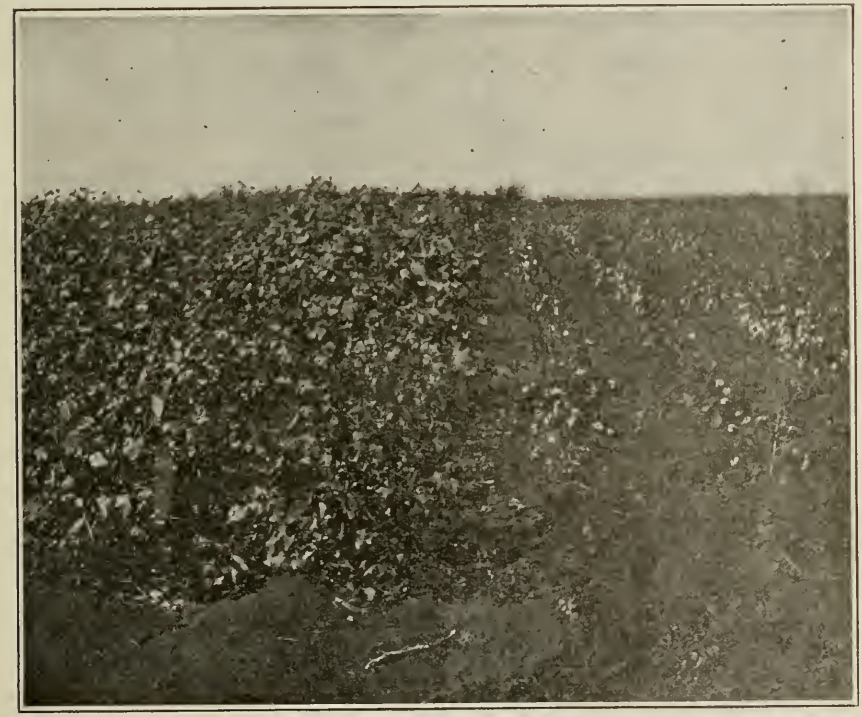

FIG. 3.—Cotton field badly infested with the root-rot, showing the result of spring subsoiling. The plat at the left, subsoiled, shows the cotton mostly alive, and the plat on the right, prepared in the ordinary way, shows the cotton nearly all dead.

the check plat which received ordinary preparation. The contrast was not so great, however, throughout the whole area. It was impossible to obtain satisfactory photographs of the plats treated by deep fall plowing, as the leaf worm had destroyed the foliage.

TREATMENT RECOMMENDED.

The benefit derived from deep fall plowing is so remarkable that it seems desirable to call the attention of cotton growers to this method of controlling the root-rot. The deep fall plowing should

be combined with rotation of crops, using, for two or three years previous to planting cotton on the land, some of the grasses or grains best adapted to the requirements of the particular locality. This course has proved most practicable and successful in combating this disease.

In order to attain success by this method the plowing must be very thoroughly done and at the proper time. Good results can not be secured unless the land is plowed to a depth of at least 7 inches, and 9 inches would be still better. This work can not be done with the small plows in general use by cotton planters. A good disk plow or a 12 to 14 inch plow of the ordinary form must be used. In the experiments of the writers the plowing was done early in December. We believe it would be better to do it in November, as the soil would have a greater opportunity to become aerated; but if it is impossible to do the plowing in the fall it should be done during the winter or early spring.

B. P. I.—274.

THE HISTORY OF THE COWPEA AND ITS INTRODUCTION INTO AMERICA.[a]

By W. F. Wight, *Assistant Botanist, Taxonomic Investigations.*

INTRODUCTION.

The purpose of this paper[b] is to give a brief history of the introduction of the plant known as the cowpea (*Vigna unguiculata*) into America, to establish as nearly as possible the time at which it was introduced, and to ascertain the region to which it is native.

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[a] Although the cowpea is the chief leguminous crop of the southern United States, the most diverse and often erroneous ideas prevail in regard to its geographic origin and the time and means of its introduction into American agriculture. It has been maintained by some, for example, that it is a native of tropical America; by others, that it was brought from Africa by the negro slaves, and by still others that it was introduced by the United States Department of Agriculture.

Because of the bearing of the question on certain introduction and breeding experiments with cowpeas, Mr. A. J. Pieters, then in charge of the seed introduction and distribution work of the Department, started an inquiry into the subject, intrusting the work to Mrs. K. S. Bort, who made extensive extracts from the literature of cultivated plants. So many questions arose, however, requiring the consideration of a botanist trained in the critical discrimination of plants and with a wide knowledge of botanical literature, that Mr. W. F. Wight was assigned to the task. He has made a thorough investigation of the history of the cowpea, and in the accompanying paper has brought forward proofs of the principal points in that history, namely, that the cowpea is a native of the Afghanistan region; that it was introduced into the West Indies over two hundred years ago, and that it subsequently was brought to the American mainland, gradually extending northward until, about 1797, it reached the latitude of the Potomac and attracted the attention of such a keen agriculturist as Washington himself.—Frederick V. Coville, *Botanist in Charge of Taxonomic Investigations.*

[b] The author wishes to acknowledge his indebtedness to Mr. Frederick V. Coville for Latin and Greek translations and for many suggestions; to the Chinese Legation for translation from the Chinese; to Mr. S. Stefansson, of the Library of Congress, for translation of Arabic; and to Mr. C. M. Mansfield, of the Bureau of Plant Industry, for photographs.

The conclusions which have been drawn are, briefly, that it was introduced into the West Indies during the latter half of the seventeenth century and probably reached the mainland during the first half of the eighteenth century; that it is a native of India and the region northwestward to the southern part of the trans-Caspian district; that its cultivation in that region is of ancient date; that its cultivation extended to China at a very early period; that it was known in Arabia and Asia Minor as early as the beginning of the Christian era, and was cultivated in at least one of the countries of southern Europe at about the same time, but that its introduction into central Europe was of much later date and entirely independent of its introduction into southern Europe.

HISTORY.

The nativity of several economic plants that have been in cultivation for a very long period is extremely difficult of determination. This difficulty is especially great in the case of the cowpea (*Vigna unguiculata*), because of its similarity to some other leguminous plants likewise in cultivation for several centuries, and the vague way in which these plants were described or alluded to by early authors.

It is evident from the statements of these authors that more than one bean-like plant was in cultivation in southern Europe before the discovery of America. It may be inferred also that at least one of these plants bore a close resemblance to the common or kidney bean[a] (*Phaseolus vulgaris*), since this species was introduced into Europe without apparently receiving the attention that a plant more unlike any known to them would have attracted. The statements regarding the origin of maize, for instance, are much more definite than those concerning the species of beans. Many of the botanical authors who wrote during the century following the discovery of America and the introduction of American species into Europe, like their predecessors, sought to identify the beans cultivated at the time they wrote with the bean-like plants described by Theophrastus and Dioscorides. This tendency is doubtless at least partly responsible for their failure to distinguish clearly the species then cultivated. De Candolle, in the "Origin of Cultivated Plants," while doubting the identity of *Phaseolus vulgaris* with any of the plants known to the ancients, after discussing the origin of the words applied to *P. vulgaris* in several European languages, says (p. 339): "Nevertheless,

[a] In this paper the expression "the common bean" is not used to designate any particular one of the many garden varieties of *Phaseolus vulgaris*, but is applied to all the forms of the species. The term "kidney bean" is used by the English and "haricot bean" by the French in the same sense.

the *dolichos* of Theophrastus has been definitely referred [by other authors] to the *scarlet runner* [*Phaseolus coccineus* (*P. multiflorus* Lam.)], and the *fasiolus* to the dwarf haricot [*Phaseolus vulgaris*] of our gardens * * * . I can only say it may be so." Again (p. 347): "*Lobion* in Dioscorides is the fruit of *Ph. vulgaris*, at least in the opinion of commentators."

De Candolle, however, apparently did not examine very carefully the evidence of the American origin of these plants. The early accounts of discovery in America contain references to leguminous plants which indicate that they were extensively used by the natives of the New World.

Hariot, 1588, "A Brief and True Report of the New Found Land of Virginia," mentions two kinds: One, "Okindgier, called by us *Beanes*, because in greatness and partly in shape they are like to Beanes in England; saving that they are flatter, of more divers colours, and some pide. The leafe also of the stemme is much different." The other plant, "Wickonzowr, called by us *Peaze*, in respect of the beanes for distinction sake, because they are much less; although in form they little differ; but in goodness of taste much, and are far better than our English peaze." Captain John Smith, 1612 (Workes, 62), writes: "They plant also pease they cal Assentamens, which are the same they cal in Italye, *Fagioli*. Their Beanes are the same the Turkes cal Garnanses, but these they much esteeme for dainties."[a] The same author, 1616 (Works, 207), in a description of New England, mentions "beans and pease" among the "hearbes and fruits," but gives no descriptions. Josselyn, 1675 (Voyages, 73–74), distinguished four kinds of beans or peas, "French beans; or, rather American beans. The herbalists call them kidney-beans, from their shape and effects; for they strengthen the kidneys. They are variegated much—some bigger, a great deal, than others; some white, black, red, yellow, blue, spotted; besides your *Bonivis*, and *Calavances*, and the kidney-bean that is proper to Ronoake. But these are brought into the country; the others are natural to the climate." Lawson, 1714 (History of Carolina, 130, 131), mentions several kinds of "pulse" as "bushel bean," "Indian rounceval, or miraculous peas," "bonavis," "calavancies," and "nanticokes." He also says "the kidney beans were here before the English came, being very plentiful in the Indian corn fields." Brickell, 1737 (Natural History of North

[a] Gray and Trumbull, 1883, American Journal of Science, 26: 132, think these names are confounded. "*Garvance* was the French name of the Chick Pea (*Cicer arietinum*), the Spanish *garbanzo;* and it is not probable that the 'Turks' gave this name to any kind of beans; while *faginoli* was the Italian equivalent of Latin *phascoli*. Strachy's Virginian vocabulary gives *assentamens* (and otassentamens) for 'pease,' and *peccatoas, peketawes,* for 'beans.'"

Carolina, 16, 17), describes the beans of the country in the following language:

There are several sorts of Pulse in this Province; and first, the *Bushel Bean*, so called from producing a Bushel of Beans or more from one that is Planted; they are a Spontanious product in *Carolina*, and are Set in the Spring round Arbours, or near long Poles set in the Ground for that purpose, where they make a good Shade to sit under in the extremity of hot Weather; they continue Budding, Flowering, and Ripening all the Summer, until the approach of Frost, which prevents their farther Growth, and so dye; They climb prodigious high, and their Stalk is about the thickness of a Man's Thumb, the Pod grows like the *Kidney Bean*, but the Bean is flat, white, or mottled, with a purple Colour: They are extraordinary good, and well relished Pulse, either by themselves or with Meat.

The *Indian Rouncival*, or *Miraculous Pea*, so called from their long Pods and great Increase. These are a late Pea, and require a pretty long Summer to ripen and bring them to Perfection, they are a good Pulse, and in great plenty all over this Province with *Christians* and Indians.

The *Bonavis* is another kind of *Pulse*, and yields a great Increase, it doth not require so long a Summer to ripen as the former, they grow like *Kidney-Beans*, and are very plenty in this Province.

The *Calivances* are another kind of *Pulse*, resembling the former, but are not so flat, they are in great plenty in most of the Plantations amongst the Indian Corn. These and the *Bonavis*, afford two Crops in the Year, and are generally ripe and in full perfection in six Weeks time.

The *Nanticoacks* are another kind of *Pulse*, and resemble the *Calivances*, and are in great plenty all over this Province.

There are several other kinds of *Pulse* in this Province that we have no Name for, which are well known amongst the *Indians*, and are excellent Food.

The *Kidney-Bean*, is likewise here in great plenty growing for the most part in every Corn-Field. The Indians had these four Sorts of *Pulse*, *viz.* the *Bonavis*, *Calivances*, *Nanticoacks*, and *Kidney-Beans*, and several other sorts, long before the Arrival of the *Europeans* amongst them: which Report I have had affirmed several times, not only from the *Christians*, but likewise from the *Indians* in these Parts.

These references and many others given by Gray and Trumbull, 1883 (American Journal of Science, 26: 130–138), and by Sturtevant, 1887 (American Naturalist, 21: 327–331), certainly justify those authors in the conclusion that *Phaseolus vulgaris*, *P. coccineus*, and *P. lunatus* are natives of the New World. Koernicke, 1885 (Verhandl. Nat. Hist. Rhein. & Westphal. Correspondenzblatt, 136), also arrived at the same conclusion in regard to *P. vulgaris*. The recent discovery of seeds identified as *P. vulgaris* in the remains of the mound builders in Ohio and of the cliff dwellers in New Mexico[a] affords evidence additional to that presented by the above authors of the nativity of that species. But among all the references given there is no positive evidence that any species of Dolichos or Vigna was in cultivation by the Indians for at least a hundred years after

[a] Wittmack, 1905, Trans. Acad. Sci. St. Louis, 15: 14.

the first English settlement. The authors of the eighteenth century record a greater number of legumes than the authors of either the sixteenth or seventeenth centuries, and there are frequent references in the literature of that period to the introduction of seeds from the Old World. Not a single species of Dolichos is known except in a cultivated state in North America north of Mexico, and Hemsley does not enumerate any in the Biologia Centrali-Americana. Only one species of Vigna, *V. repens*, now found spontaneous throughout the Tropics, has the appearance of being indigenous to either North or Central America, while about 10 species of Phaseolus are known in a wild state in North America, and Hemsley enumerates 41 in the Biologia Centrali-Americana for Central America.

The time at which important American food plants were introduced into England is also significant in regard to the origin of these plants. The following dates are given on the authority of Aiton (Hortus Kewensis, 1789): *Zea mays* was cultivated in 1562; *Nicotiana tabacum* before 1570, but the exact date is apparently not known; *Lycopersicon lycopersicum* was cultivated in 1596; *Phaseolus vulgaris* in 1597, and *P. coccineus* (*P. multiflorus* Lam.) in 1597. The date given for *P. lunatus* is 1779, but the figure and description of Gerard's third kind (Gerard, 1597, Herbal, 1039), correspond very closely to the so-called sieva type of *P. lunatus*, and it is possible that it had been introduced at an earlier date and, not meeting with favor, disappeared, but there is no evidence that *Vigna unguiculata* and *Dolichos sesquipedalis* were introduced into England before 1776 and 1781, respectively. With one possible exception, therefore, plants of undoubted American origin were cultivated in England more than a century and a half before *Vigna unguiculata* or *Dolichos sesquipedalis*. This would scarcely have been the case if the two last-named species had been cultivated in America for a long period, as the first-named were.

Of the two kinds distinguished by Hariot in 1588, the one called "Peaze" is without doubt the kidney bean, as it is called "Peaze, * * * for distinction sake * * * though in form they little differ" from the bean except in size. The latter is compared with the English bean (*Vicia faba*) in size and partly in shape, and is either a large form of kidney bean or the Lima bean. If the words "Fagiole" and "Garnanses" or garvanses are confounded by Smith, the "pease" which he mentions probably refers to a species of Lathyrus or Vicia, and the "Beanes" to the common kidney bean. There can be little doubt that "Garnanses" is a corruption of the Spanish *garbanzo*, French *garvance*. It has also been written "garavance," "garvancos," and "gravances." The writer has been unable to find

this word used in Europe for any other plant than the chick-pea (*Cicer arietinum*), and although the introduction of seeds into America began as early as the second voyage of Columbus, it is improbable that the cultivation of the chick-pea could have been introduced among the Indians of the United States as early as 1612, and it is doubtful whether it was ever cultivated by them.

There is no evidence that it was cultivated to any extent by the colonists, though it was introduced some time previous to 1790. The name was probably applied by Smith to some plant with a superficial resemblance to the chick-pea, perhaps a vetch. There is at least no evidence that the plant called "garnanses" was a species of either Vigna or Dolichos. The name "calivance" was applied by Sloane, 1707 (Natural History of Jamaica, 1:183), to the cowpea, and this word is believed to be a corruption of "garbanzo." The forms given in Murray (English Dictionary, under Calavance) are, "garvance," "caravance," "callavance," "callevance," "callvanse," "kalavansa," "callivancy," "callivance," "calavance." The earliest use of the word "calavance" that the writer has been able to find is by William Hughes, 1672 (The American Physician, or a Treatise of the Roots, Plants, Trees, Shrubs, Fruit, Herbs, etc., 17, 18), where he writes concerning "Calavance, or Calavances:"

> These Pease have long and small stalks, of a brownish green colour, branched and spread upon the ground (unless they be supported by Props) much after the same manner of our Field-pease; the leaves shoot forth at several places, set one against another, of a more yellowish green colour than ours in *England* are: They have also towards the top, clasping Tendrils, as ours have: The Cods are pretty long, wherein are small Pease of the bigness of our Vetches, but long: or of the fashion of a Kidney-bean, and very smooth; outwardly, of a dark red colour; neither are they uneven when they be dry.
>
> They grow in many places in *America*, as in *Jamaica*, at Colonel *Barington's* Plantations, at Ligance, at Portamorant, etc.
>
> They are planted at any time, and flourish all the year; of which the Husbandmen or Planters there, have five crops in two years.
>
> Some call them the *Indian Vetches*, some the *Indian Pease;* but those that are Inhabitants there, call them *Calavances*, or *Calievancie*.

The plant described by Hughes is certainly a plant with pinnate leaves and tendrils, like the chick-pea, but Sloane, 1696 (Catalogus Plantarum Jamaica, 71), cites "Calavance or calavances of Hughes, p. 17 (?)," under *Phaseolus erectus major*, which is a cowpea. The same author, 1707 (Natural History of Jamaica, 1: 183), under *Phaseolus erectus major*, says "Callavance Jamaicensibus dictus," without any indication of doubt. It would appear from these facts that the word was originally used in America to designate a vetch-like plant and that its application to the cowpea by Sloane was an error. Several authors subsequently adopted Sloane's usage of the

name, and it is preserved at the present day in the form "galavant" as the name of one of the varieties of the cowpea.

The four kinds mentioned by Josselyn, 1675 (Voyages, 73–74), are "kidney-beans," "bonivis," "calavances," and the "kidney-bean that is proper to Ronoake."

Bonivis is clearly a corruption of Italian *Buona vista*, and Hughes, 1750 (Natural History of Barbadoes, 216), writes "*Buona Vista*, commonly called *Bonny-eis*." Its earliest use in America appears to be by Richard Ligon, 1657 (A True and Exact History of the Island of Barbadoes, 22, 24), "Maies, and Bonavists, planted between the boughs, the Trees lying along upon the ground; so far short was the ground then of being cleared." No description is given by which the name can be identified with a particular species, and its application can only be inferred from its later use by other authors. Sloane, 1696 (Cat. Pl. Jam., 67, 68), and 1707 (Nat. Hist. Jam., 1:177), uses bonavist for *Dolichos lablab*. The "Buona vista" of Hughes, 1750 (Nat. Hist. Barbadoes), is also certainly *Dolichos lablab*. Wherever the word "bonavist" in its various forms occurs with an identifiable description it refers to *Dolichos lablab*. Josselyn's "calavances," like that of William Hughes, is probably a plant with pinnate leaves. Certainly no variety of *Vigna unguiculata* then known would mature seeds in New England. The "kidney-bean that is proper to Ronoake" may be either the Lima bean, the scarlet runner, or one of the numerous varieties of the kidney bean.

The "bushel bean" of Lawson is probably *Phaseolus lunatus*. Sturtevant, 1885 (Amer. Nat., 19:454), has suggested that the "Indian rounceval, or miraculous peas," may have been *Dolichos sesquipedalis*, but it would have been more natural for an Englishman to have applied the term to a plant more nearly resembling the English rounceval. Lawson's "bonavis" is doubtless *Dolichos lablab*, but "calavancies" and "nanticokes" are scarcely identifiable, though the latter is probably one of the various forms of the kidney bean. Brickell gives nearly the same description of bushel bean and Indian rounceval as found in Lawson; in fact, the wording is so familiar that it is without much doubt copied from the earlier author. There is less doubt, however, regarding the "Calivances" of Brickell. They resembled the bonavis, except that they were not so flat. This clearly refers to some other plant than a Vicia or Lathyrus, and though it can not be identified from the descriptions, it must be either a form of *Phaseolus vulgaris* or perhaps the red-seeded form of *Vigna unguiculata*, the "callavance" of Sloane.

Jamaica was captured by the British in 1655, and possession was confirmed by treaty in 1670. William Hughes (The American Physician, etc., published in 1672), describes several plants cultivated in

Jamaica, but does not include *Vigna unguiculata*, his calavance, as noted above, being a different plant. If *Vigna unguiculata* had been cultivated in Jamaica at that time it would probably have been mentioned with the other cultivated legumes Hughes described. Sloane visited the island in 1687, remaining fifteen months, and found both the red and white seeded forms, and it is therefore very probable that they reached Jamaica some time between the years 1672 and 1687. Any plant that had been found valuable in Jamaica would no doubt soon be tried in the southern colonies, for the early accounts of the colonies indicate that they frequently obtained seeds of new plants for trial. The Georgia colony even sent a man to the Spanish West Indies to secure new plants (Francis Moore, 1744, A Voyage to Georgia, Georgia Historical Society, 1840, 1:99). It is therefore possible that even the calavance of Lawson, 1714, is *V. unguiculata*. The statement of Brickell, 1737 (Natural History of North Carolina), that these plants were in America before the arrival of the Europeans can scarcely be taken seriously, for he makes it on the authority of the settlers and Indians who would easily confuse plants so similar in appearance as *Vigna unguiculata* and *Phaseolus vulgaris*. The exportations of peas mentioned by some of the early historians probably refer to English peas, as Lawson, 1714 (Hist. Carolina, 130, 131), says English peas "have been made trial of" and "yield very well."

The first unmistakable reference to the occurrence of *Vigna unguiculata* on the mainland of America appears in Romans (1775), Natural History of East and West Florida, 122, where the author says: "Pease, as they are here called but improperly, because species of the *Phaseolus* and *Dolichos* are meant, follow the maize in utility. It is well known that most people use them like European pease either green or dry, and some kinds, such as the small white sort, the bonavist, cuckolds increase, the white black-eyed pea, the white crowder, and many others, are undoubtedly at least as good." The "small white sort" is doubtless a white variety of the common bean; bonavist probably refers to *Dolichos lablab*. "Cuckolds increase" is applied by Patrick Brown, 1756 (Natural History of Jamaica, 292), to a species which he says resembles his seventh species, "Phaseolus erectus major," Sloane, which is *Vigna unguiculata*. Lunan, 1814 (Hortus Jamaicensis, 1:434), says the "cuckolds increase" "seems to be a species of *dolichos*, as does the bonavist." The white black-eyed pea is undoubtedly identical also with the black-eyed pea of Jamaica, another common form of *Vigna unguiculata*. The "white crowder" does not appear to be described by either Sloane or Brown. With the exception of the "small white sort" and the "white crowder" the names given by Romans were also given by Brown nineteen years earlier, and by Lunan thirty-nine years later, and the fact that

the names "calavance," "bonavist," "cuckolds increase," and "black-eyed pea" all appear in the natural history literature of the West Indies earlier than they occur in the accounts of the American colonies indicates that they came from the West Indies to the mainland. Lunan, 1814 (Hortus Jamaicensis, 1:167), under "Dolichos" says: "Besides the above indigenous species, three exotic ones have been introduced, the lablab, of which arbours are made in the East; the *sinensis*, or Chinese dolichos; and the catjang, which is said to be cultivated for food in the East Indies."

The discussion given by Romans indicates that "pease" had been grown in the southern colonies for several years, long enough at least for their use to become "well known." In Virginia, however, there is evidence that *Vigna unguiculata* was not cultivated, at least to any extent, at so early a date. The correspondence of Washington affords interesting evidence of this fact. A letter dated Hyde-Park, Fairfax County, November 18, 1791, in reply to a circular letter sent out by Washington (Letters on Agriculture to Arthur Young and Sir John Sinclair, edited by Franklin Knight, 51, 1847), contains the following statement:

> As to pease, beans, potatoes, and turnips, our lands yield them very well, but as they are not raised for market in general I can not say what may be their average product per acre. It has ever appeared to me that if the farmers in Europe, who lay so much stress upon these articles in their writings, had our excellent substitute for them, Indian corn, they would only regard them as we do, for culinary purposes.

Washington was accustomed to growing seeds of new plants that might prove of agricultural value, and there are frequent references in his correspondence to seeds which had come from England or other countries and of which he wished the gardener to take particular care. The following are mentioned in Washington's correspondence, besides the staple crops of corn, wheat, etc.: Lucern, sainfoin, India hemp, buckwheat, furze, flax, white bent-grass, everlasting peas, and English field peas.

It was Washington's practice, sometimes, at least, to plant potatoes with corn, since in a rotation of crops recorded in "George Washington and Mount Vernon," edited by M. D. Conway, 287, 1889, "Indian corn, with intermediate rows of potatoes, or any root more certain or useful (if such there be) that will not impede the plough, hoe, or harrow in the cultivation of the corn," is given for one crop of the rotation. There is apparently no reference in any letter of Washington to the cultivation of peas or beans with corn. He used buckwheat as a green manure.

The first reference by Washington to the cowpea is in a letter to Landon Carter, of Cleve, dated Philadelphia, 27th February, 1797,

in which he says: "I hope, as the season is approaching fast when the ground should be prepared for it, that you have informed Mr. James Anderson (my manager) in a letter directed to the care of the postmaster in Alexandria, at what time he may send for the peas you were so obliging as to promise me;" and the following from a letter of James Anderson to Landon Carter, which accompanied the above letter of Washington. "I have only to add to that wrote by the President—that the sooner you have 40 bushels of the White Indian pease, with black eyes—ready, you will the more oblige the President, I do not wish any of the small kind either the round kind called the Gentlemen pease, nor of the other small kind which resemble the large."

Jefferson, 1801 (Notes on the State of Virginia), makes no mention of peas or beans, although he enumerates the cultivated plants (p. 58), saying—

> Our farms produce wheat, rye, barley, oats, buckwheat, broom corn, and Indian corn. The climate suits rice well enough, where the lands do. Tobacco, hemp, flax, and cotton, are staple commodities. Indigo yields two cuttings. The silk-worm is a native, and the mulberry, proper for its food, grows kindly.
>
> We cultivate also potatoes, both the long and the round, turnips, carrots, parsnips, pumpkins, and ground nuts (Arachis). Our grasses are lucerne, St. foin, burnet, timothy, ray and orchard grass; red, white, and yellow clover; greensword, blue grass, and crab grass.
>
> The gardens yield musk-melons, water-melons, tomatos, okra, pomegranates, figs, and the esculent plants of Europe.

Beans and peas are not mentioned, and it may therefore be inferred that neither was at that time of sufficient importance in northern Virginia to be listed among the farm crops. A legume, probably *Vigna unguiculata*, was, however, cultivated in the cornfields to some extent in southern Virginia some years earlier than the publication of Jefferson's Notes.

Dr. James Greenway, of Dinwiddie County, Va., in an article on *Cassia chamaecrista* as a soil renovator (Transactions of the American Philosophical Society, 3: 226, 1793), says the "common cornfield-pea is far preferable to everything that I have seen tried for this purpose. Every farmer who leaves his pea vines on the ground, and does not in the accustomed manner, pull them up for fodder, must often have observed that they quickly moulder and fall to pieces; furnishing a covering to the ground, which readily unites and blends with it, in the manner mentioned of the bean" [i. e., *Cassia chamaecrista*].

A catalogue of the plants found growing near Lancaster, Pa., by Muhlenberg, 1793 (Transactions of the American Philosophical Society, 3: 157), in which cultivated and introduced plants are given, as well as wild plants, does not mention any Dolichos or Vigna. The cowpea evidently had not then reached that locality.

It may be seen from the facts presented that there is no evidence that *Vigna unguiculata* was one of the native beans of America. On the contrary, it appears to have been first introduced into Jamaica at some time between 1672 and 1687 and to have reached one or more of the southernmost colonies, probably from Jamaica, sometime after the latter date, but before 1737, and its use to have extended gradually northward until it reached the Potomac about 1790 or 1795.

Notwithstanding the confusion wrought by commentators seeking to identify *Phaseolus vulgaris* with one of the climbing plants of Theophrastus and Dioscorides, European botanical literature affords very convincing evidence of the Old World origin of *Vigna unguiculata*.

Phaseolus vulgaris appears to have reached central Europe about 1536, and many authors at once identified it with Dioscorides's Smilax kepaia, or, as translated into Latin, Smilax hortensis. The species is discussed by Brunfels, 1536 (Herb. Viv. Ic., 3: 130), and identified on the authority of Heironymus Tragus with Dioscorides's plant. Brunfels in his Exegesis omnium simplicium Dioscorides (Brunfels,[a] 1532, Herb. Viv. Ic., 2: 114), does not identify Smilax more than to say that, according to Barbarus, it is a kind of phaseolus, and it is evident that *Phaseolus vulgaris* was not known to this author when volume 2 of his work was written. Bock, 1546 (Kreuterbuch, 236), has a good colored figure of the kidney bean, and says it has lately come into Germany.

Matthiolus, 1588 (Opera, 341), says that phasioli are common in Italy, but he apparently confuses the dwarf form of *Phaseolus vulgaris* with the "phasiolus" of the ancients. No stipules are shown in his figure, and it is probably *Phaseolus vulgaris*. In the earlier editions of Matthiolus's works, which appeared while the author lived in Italy and southern Austria, no bean with "black-eyed" seeds is described among the various sorts of "phasiolus." In a later work, Matthiolus, 1565, Commentarii, 429, the dedication of which was written at Prague, and dated January, 1565, seeds with a black ring about the eye are described, but the figure is the same as in the work issued in 1558. In Camerarius's edition of Matthiolus, 1586 (De plantis epitome utilissima, 212), however, the figure of phaseolus is *Vigna unguiculata*. It is certain that a low-growing leguminous plant, resembling the dwarf form of *Phaseolus vulgaris*, was cultivated in the Mediterranean region of southern Europe before the discovery of America. Several of the ancient treatises on agriculture give cultural directions for such a plant. Many, if not all, of the

[a] The edition of this work published in 1536 was the one consulted.

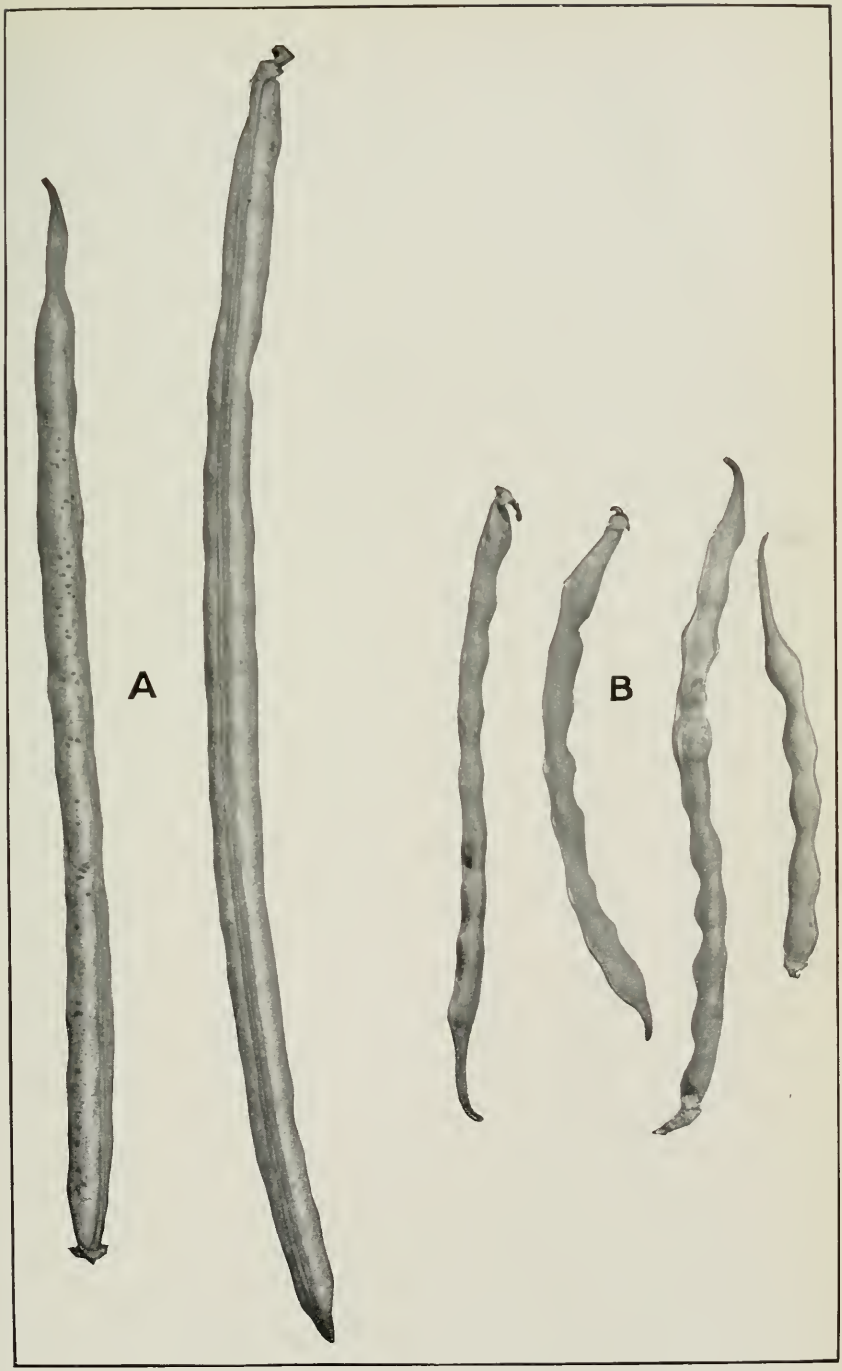
botanical authors after Dioscorides mentioned phaseolus, and Albertus Magnus, who lived in the thirteenth century, used the word "faselus" for a plant which had seeds with "a black spot at the hilum." Caesalpin, 1583 (De Plantis, 238), also described "phaselus" as having seeds with a black pupil.

Koernicke, 1885, Verhandlungen des naturhistorischen Vereins der preussichen Rheinlande, Westfalens und des Reg.-Bezirke Osnabrück, Correspondenzblatt, 136, maintains that the phaseolus of Dioscorides and the phaseolus cultivated in Italy before the discovery of America were the same species, "*Vigna sinensis*," and that the "Smilax kepaia" of Dioscorides was likewise that species, but a climbing form. Koernicke states that a work of the year 1415, by Rinio, a Venetian physician, contains a colored illustration of "Faseolus," and he identifies this as *Dolichos melanopthalmus* DC. He says also that in both Codices of Dioscorides of the fifth century after Christ, which illustrate the plant named phaseolus, the figures are likewise the low form of *Vigna unguiculata*, while for Smilax kepaia an illustration is wanting. Koernicke, however, believes *Dolichos melanopthalmus* DC., *D. monachalis* Brot., *D. lubia* Forsk., *D. sesquipedalis* L. to be low forms, and *D. catjang* L., D. *sinensis* Stickman, and *D. tranquebaricus* Jacq. to be climbing forms of the same species. Baker, 1879 (in Hook. Fl. Brit. India, 2:206), gives *V. sinensis* as the climbing and *V. catjang* as the low form. Koernicke says that the variation in the seeds is not greater than in *Phaseolus vulgaris*, and that dried plants in the Berlin Herbarium show no specific differences. *Vigna sinensis* (*Dolichos sinensis* Stickman) on the basis of priority is adopted by Koernicke as the correct name of the species, but he apparently overlooks the fact that *Dolichos unguiculatus* L. (*Vigna unguiculata* (L.) Walp.) is still earlier. Koernicke gives central Africa as the original habitat of the species. *Dolichos scsquipedalis*, the asparagus bean, is considered a distinct species by most authors, and the writer can not agree with Koernicke that all the other names apply to the same species or that central Africa is the home of any of them. It is true that the habit of growth, whether low or a climbing form, is of no specific value, for *Vigna unguiculata* at least seems to vary in this respect.

The color of the seeds likewise fails as a distinguishing specific character. *Dolichos unguiculatus* L. was founded on specimens grown in the garden at Upsala, but came to Linnæus from Barbados. *Dolichos sinensis* was based on *Dolichos sinensis* or *Katjang Sina* of Rumphius, and the figure in Rumphius Herbarium Amboinense shows a climbing plant with two-flowered racemes and pendulous pods. *Dolichos catjang* is likewise based on a species of Rumphius, *Phaseolus minor* or *katjang poeti*. The figures of this

PLANT OF VIGNA CATJANG (BURM.) WALP.

PLANT OF VIGNA UNGUICULATA (L.) WALP.



PODS OF COWPEAS.

A.—*Vigna unguiculata.* B.—*Vigna catjang.*

(Natural size.)

species shows a plant with the racemes two or three flowered, but with the pods at maturity smaller and erect, or nearly so, and with smaller seeds. A species grown in the greenhouses of the United States Department of Agriculture shows similar characters, the pods remaining erect until full grown, although they become pendent at maturity. The pods are also conspicuously torose at maturity. This species is *Vigna catjang* (Burm.) Walp. (Pl. I and Pl. III, B). Practically all of the varieties commonly cultivated in America belong to *Vigna unguiculata* (L.) Walp. (*V. sinensis* (Stickman) Endl.), the species with larger seeds and larger pods which usually become pendulous when half their mature size or sometimes even earlier, and which are only slightly constricted between the seeds (Pl. II, and Pl. III, A). Forskal, 1775 (Fl. Aegypt-Arab., 133), described *Dolichos lubia* as having peduncles racemosely spicate at the apex and the flowers crowded, and it may therefore be inferred that the racemes were several-flowered. The pods were described as erect. The color of the seeds is not mentioned by Forskal, but Delile, 1812 (Plant. Cult. en Egypt, 14), says they were white, with a black point at the eye. Koernicke says the "ring about the navel is pale red," and the seeds labeled *D. lubia*, recently received from the Muséum d'Histoire Naturelle, Paris, are quite small, red, with a black ring at the hilum. The varieties of *Vigna unguiculata* commonly cultivated in America seldom vary from the few-flowered character of the raceme and, at maturity, pendulous pods. Delile says *Dolichos lubia* is known also in Syria, Persia, and India, but there is but one other modern author who has applied the name to any species in Asia. Basiner, 1848 (Beitr. Russ. Reich., 15:233), gives *Dolichos lubia* as one of the forage plants of Khiva, where it was known as "Lobia" or "Lobi." No description is given, and therefore its identity with Forskal's plant is not certain.

The fact that Delile says it was found also in India, but does not mention any species of Vigna, suggests that his plant may have been *Vigna unguiculata* or *Vigna catjang*. Roxburgh, 1832 (Fl. Ind., 3: 302), described *Dolichos sinensis* as with peduncles "many-flowered," and *D. catjang*, few-flowered. Baker, 1879 (Hook. Fl. Brit. Ind., 2:206), unites the two as *V. catjang* and says peduncles 3 to 6 flowered. Baker, 1871 (Oliver, Fl. Trop. Afric., 2:204), describes the racemes of *Vigna sinensis* as 6 to 12 flowered and the pods pendulous. It appears, therefore that the few-flowered character of the raceme usually observed in varieties cultivated in America is not constant in either *Vigna unguiculata* or *Vigna catjang*. The descriptions cited above indicate a variation of from 3 to 12 in the number of flowers, and the plant described by Forskal as *Dolichos lubia*, since it had erect pods, is doubtless identical with *V. catjang*. Yet, not-

withstanding the variation in habit and number of flowers in the raceme, the small seeds and small, erect pods of *Vigna catjang* appear to be constant characters, and two species, *Vigna unguiculata* (*V. sinensis*) and *V. catjang*, therefore are probably concerned in the descriptions of these plants by the above authors.

It is quite possible that *Vigna unguiculata* and *V. catjang* may have been grown by the Romans without being distinguished. The cultivation and even knowledge of them, however, appears to have been extremely limited in Europe, and *V. unguiculata* at least may have first reached central Europe not from Italy, but by way of Russia and Russian Turkestan.

In 1583 Clusius (Atrebatis Rar. Stirp., 725) described and figured a plant as a kind of phaseolus which is undoubtedly *Vigna unguiculata*, though pods are not shown in the figure. Seeds of this plant were received by Clusius at Vienna in the year 1576, having been sent by Dodoens from Prague, where it was grown in the garden of the castle the previous year. The following year, 1577, seeds of the same plant were also sent by the Spaniards to the Austrian Emperor. These statements are repeated by Clusius, 1601 (Hist. Rar. Pl., p. ccxxii), where the same figure, as in the previous work, is reversed and a figure of the pods in addition is given. It would appear from these records that *Vigna unguiculata* first became known to the botanists of central and northern Europe by its being grown at Prague.

If seeds had reached Prague from Italy, the plant would probably have been known also at Vienna, which was in the route of trade from Italy northward, and, since Prague is an inland city, the seeds may have been brought overland directly from Persia or India. So long as the Venetians were in control of the trade with India, Austria and southern Germany carried on commerce with Venice. With the acquisition of the Indian trade by the Portuguese, Venice could no longer supply the markets of Europe with the products of the East and European nations apparently soon became jealous of the advantages held by Portugal, for it is stated by Robertson, 1802 (Historical Disquisition Concerning India, 319), that an attempt was made, in order to diminish the advantages which the Portuguese derived from the discovery of a sea passage around the Cape of Good Hope, to induce the Russians to convey Indian and Chinese commodities through their Empire to some port on the Baltic from which they might be distributed through every part of Europe. This author also gives a brief account of the trade thus established. Yeats, 1872 (The Growth and Vicissitudes of Commerce, 155), states that Kazan was the chief entrepôt of the trade of northern and central Asia. Russian trade with other European nations ap-

pears to have been confined largely to the countries of the north and the cities belonging to the Hanseatic League. Very little seems to have been written concerning the commerce of Prague, but the Bohemians are a Slavic people and it is not improbable that they had some trade with the other Slavic peoples of Europe. At least no explanation of the occurrence of *Vigna unguiculata* at Prague before it was known at Vienna seems so plausible as that it came by one of the caravan routes to Russia and thence to Prague. De Candolle (Origin of Cultivated Plants, 39) says *Sium sisarum* "came perhaps from Siberia into Russia, and thence into Germany," and inclines to the view that it was not known to the ancient Greeks and Romans. This species is considered to be a native of the Altai region of Siberia and northern Persia. The caravan route from India and China to Russia passed through the latter region.

The figure in Rinio, 1415 (De Simplicibus), referred to by Koernicke, the writer has not seen, but in the Vienna Dioscorides Codex, dating from about the fifth century, the figure of the plant supposed to be the phasiolus of Dioscorides shows a several-flowered raceme. It also shows what appear to be mature pods and, while not strictly erect, they are not pendulous like those of *Vigna unguiculata*. The word "lubia" is written in Arabic on the parchment and the figure corresponds very closely with the description of *Dolichos lubia*. Forskal says the latter species was known among the Arabs as "*Lubia baeledi*" (common lubiä). Dioscorides was probably born at Anazarba, a place in southeastern Asia Minor near the eastern extremity of the Mediterranean, but he is supposed to have traveled and it is not known where the plants he described may have been seen.

Koernicke believes the species to have come originally from central Africa, as it grows wild there. This, however, is not necessarily conclusive. There are other instances, especially in the Tropics, of plants appearing indigenous to countries in which they are known not to be native. The facts given by Koernicke indicate rather that the species has been introduced into central Africa, for he gives no name in the native language, but says it is known to the natives by the Arabian names "lubiah" and "ollaich." Seeds of this plant have never been found in the monuments of ancient Egypt, and the origin of the word "lubia" indicates that the plant to which it was applied came into Arabia and Egypt from the east. Lubia, lubiya, or lobiya probably was not derived from the Greek word λοβός, which primarily means any projection like the lobe of the ear, but appears to be of Persian origin and came to India through the Persians. Sir George Watt, 1890 (Dict. Econ. Prod. India, 3: 184), says: "No name like *lobiya* is given to any pulse by the aboriginal races of Indian or by those of Aryan origin. It occurs purely among the

people of upper India, where Persian influence is most pronounced." The same author states that in all the districts of the northwest provinces, with but one possible exception, the word lobiya is applied to *Vigna catjang*.

Although none of the Indian works consulted that mention lubiya are of such ancient date as Dioscorides, they nevertheless indicate the antiquity of its cultivation in India. *Vigna catjang*, the species with erect pods, is described and figured in Rheede, 1688 (Hort. Malabar, 8:75. *t. 41*), under the name *paeru*. It is interesting to note that the root nodules were mentioned in this work, "The root is slender, whitish, and fibrous, the fibers clothed with round globules." Rheede described nine different preparations of the seed which were used in medicine. Other bean-like plants occur in the same work under the names *putsja-paeru* and *catu-paeru*, which indicates that the paeru was better and probably longer known than the plants to which compound names were given. In a work, Ain-i-Akbari or Ayeen Akbery (Institutes of the Emperor Akbar), written in Persian during the reign of the Emperor Akbar, 1556–1605, describing the crops grown in Delhi and Agra, translated by Francis Gladwin, 1783, 1:87, "lubya" is given as one of the crops of the autumnal harvest. Sir George Watt states that at the present time this would be *Vigna catjang*, and in all probability would have been the same in Akbar's time. Sir George Watt gives nearly 50 vernacular names in different Indian languages, of which only four are compound words and only four others consist of more than one word. One of the Sanskrit names given by Watt is *nishpáva*. In the Vishnu Purana, lib. 1, cap. 6, supposed to date from about 1045 A. D. (translation by Horace Wilson, Complete Works, 6:95), "Nishpáva, a sort of pulse," is mentioned in the list of important grains. This work is five hundred years later than the illustration in the Vienna Dioscorides Codex. Nevertheless, Sanskrit for two thousand years or more has led an artificial existence, being the means of communication and literary expression of the priestly and learned castes, and the writer finds no indication that the name nishpáva has ever been applied to any other plant.

The species appear to be probably of less ancient cultivation in China, for there is no indication of a Chinese introduction into India or Persia, and it is improbable that the same species would be native on both sides of such a natural barrier as the Himalayas. Nevertheless, *Vigna unguiculata* at least appears to have been long cultivated in China. It is mentioned and illustrated in the second edition of the Kiu Huang Pen Ts'ao, which appeared in 1559. In this work it is called the "common bean," and other beans are compared with it. It has not been practicable to consult the first edition of this work, pub-

lished in the beginning of the fifteenth century, and whether it appears there or not is uncertain.

It may be noted that no plant of American origin has been identified in any Chinese work previous to the Pen Ts'ao Kang Mu, which was finished in 1578, though not published until after 1596.

It may be concluded from the facts so far known regarding these species that both *Vigna unguiculata* and *V. catjang* originally came from a region including and extending from India to Persia and the southern part of the Trans-Caspian district, and that the Persians called one or both of them by the name "lubia" and applied that name to *V. unguiculata* in northwest India after their conquest of that region. The cultivation of *V. unguiculata* extended to China at a very early date, but the distribution of at least one of the species with the name "lubia" had extended from the region of its origin at the beginning of the Christian era to Arabia and Asia Minor and had reached some of the Mediterranean countries of Europe at about the same time, but did not become known in central Europe until the middle of the sixteenth century.

B. P. I.—287.

A NEW METHOD FOR THE DETERMINATION OF NICOTINE IN TOBACCO.[a]

By Wightman W. Garner, *Scientific Assistant, Tobacco Breeding Investigations.*

THE RELATION OF NICOTINE TO THE QUALITY OF TOBACCO.

Nicotine is the characteristic alkaloid of tobacco, and thus far has not been found in any other plant. Its function in the economy of the plant is not understood, and it has not been determined with certainty whether it plays a rôle in nutrition or is simply a waste product resulting from katabolic changes in the albuminoid constituents. The physiological effects on the human system resulting from the use of tobacco are doubtless due chiefly to the presence of nicotine, though in the case of tobacco used for smoking purposes other constituents of the smoke probably play a considerable part. On the other hand, it has been repeatedly shown that the burn, flavor, aroma, and other important qualities of tobacco are in no sense pro-

[a] In the Tobacco Breeding Investigations conducted by the Bureau of Plant Industry careful experiments have been undertaken to determine the relation of the nicotine content of cigar filler and wrapper tobaccos to the quality of these tobaccos. It has been found in the preliminary experiments carried out by Dr. W. W. Garner, of this office, that the nicotine content of the leaves of different tobacco plants grown under the same conditions varies in a striking manner. The variability of the nicotine content of individual plants has suggested the possibility of securing, by breeding and seed selection, strains of the different varieties of cigar wrapper and filler tobaccos possessing a low or a high nicotine content. The large number of nicotine determinations necessary in the carrying out of these tests has required a great expenditure of time and money owing to the complicated and expensive method of determination. The new method of determining the nicotine content of tobacco described in this bulletin greatly simplifies the work of the experimenter by enabling him to make many more determinations in the same length of time than by any previous method. This method also is very much less expensive than any previous method and, as shown in this bulletin, is more satisfactory from the standpoint of accuracy and reliability. The relation of the nicotine content of tobacco to the quality and other characteristics of tobacco and the possibility of breeding tobacco low or high in nicotine content will be presented in more detailed future reports of the Department.—A. D. Shamel, *Physiologist in Charge of Cotton and Tobacco Breeding Investigations.*

portional to the amount of nicotine present. Indeed, even the "strength" of manufactured tobacco—using this term in the sense understood by the trade—is not dependent upon the nicotine content. It seems only reasonable, however, to suppose that tobacco entirely free from nicotine would no longer prove satisfying to the consumer any more than would whisky deprived of all its alcohol.

Numerous attempts have been made to devise a process for the partial removal of the nicotine from tobacco, either before or after it is manufactured, by appropriate treatment, and many patents have been issued for processes intended to accomplish this result, but none of the proposed methods has as yet proved sufficiently practicable to come into general use, and this is not surprising when it is remembered that the flavor and aroma of tobacco are comparable in delicacy to those of tea and coffee and that consequently even the mildest treatment for the removal of the alkaloid is almost certain to result in injury to these qualities.

There can be no doubt that there would be a genuine demand for tobacco containing only a very small percentage of nicotine but retaining the other attributes of the best grades of the crop as now produced, especially in the case of the cigar-filler types. The most rational method of attaining this end would seem to lie in the systematic breeding of types characterized by their low nicotine content, and at the same time avoiding those soils, fertilizers, and cultural methods which tend to the excessive production of the nitrogenous constituents of the plant. Extensive experiments have been undertaken in connection with the Tobacco Breeding Investigations of the Bureau of Plant Industry with the object of securing types of tobacco of this kind, and the results already obtained tend to show that the variation in nicotine content of individual selections from various types is fully as great as that of such physical characteristics as shape, size, and number of leaves. Since nothing like sufficient data are available for establishing any constant relation between the physical characteristics of different tobacco plants and their nicotine content, these experiments necessitate the accurate determination by analysis of the quantity of the latter in a very large number of selected plants.

THE QUANTITATIVE DETERMINATION OF NICOTINE IN TOBACCO.

In order to conduct these experiments on a sufficiently comprehensive scale it is imperative that there be available a method for the estimation of nicotine which is reasonably accurate and is at the same time rapid, so that a large number of determinations may be completed in a day's work. Kissling[a] has developed a method which

[a] Zeitschr. Analyt. Chem., XXII, 199.

seems to have given satisfactory results in the hands of most analysts, and has come to be recognized as the standard process. But this method is long and tedious, and hence is not adapted to our needs. It consists essentially in moistening the powdered sample with aqueous caustic soda and extracting with ether for several hours in a suitable form of continuous extraction apparatus. The ether is carefully distilled from the extract, and the residue is subjected to distillation with steam. The distillate is collected in 100 c. c. portions and titrated with a standard acid. It is apparent that the process is an expensive one, both in point of materials consumed and necessary equipment and in the time required for carrying it out.

Keller[a] has described a method which is simple and rapid in execution and avoids the tedious process of distilling the extracted nicotine with steam. Six grams of the tobacco, previously dried over lime, are placed in a cylinder with 60 grams of ordinary ether and 60 grams of petroleum ether, and 10 c. c. of 20 per cent aqueous caustic potash are added. The contents of the cylinder are vigorously shaken for thirty minutes and then allowed to stand for three hours to clarify. The extract is filtered and 100 grams of it placed in a cylinder. To remove the ammonia in solution, a rapid current of air is blown through the extract, after which there are added 10 c. c. of water. After shaking well, an excess of standardized hydrochloric acid is added and the titration completed with standardized ammonia. With some minor modifications the method gives fair approximations, but we have found that it is unsuited to our requirements. In point of materials consumed it is even more expensive than the Kissling process, and it also contains several sources of error. Adding 10 c. c. of aqueous potash to the ether mixture increases the total weight of solvent more than 8 per cent, and considerable quantities of nicotine remain in the aqueous portion. Ordinary ether boils at 36° C., which is but little above ordinary room temperatures, and consequently it is quite impossible to filter the extract without very considerable loss of the solvent by evaporation. Again, most tobaccos yield extracts which are so deeply colored that the nicotine can not be titrated with accuracy until the solvent has been removed. This is the principal reason why it is necessary to subject the extract obtained by the Kissling process to distillation with steam. From the results of our experiments with Keller's method, supplemented by further tests along other lines, we have developed a process which differs essentially from Keller's in all of the details of the operation and obviates the difficulties encountered in the latter.

[a] Ber. Pharm. Gesell., 1898, 145.

Nicotine is readily soluble in nearly all of the ordinary solvents, and hence there is no difficulty in extracting it completely from tobacco after it has been liberated from its salts by means of a fixed alkali. The separation of the nicotine from ammonia and amid bodies, which are always present in tobacco, is the principal problem to be solved in this connection. By using such solvents as ether and ligroin, however, only the nicotine and a portion of the ammonia are contained in the extract, and it is possible to remove subsequently practically all of the ammonia by appropriate methods.

THE PROPOSED NEW METHOD.

In endeavoring to devise a method for estimating nicotine suited to our requirements, three principal objects were kept in mind, namely, the use of a comparatively cheap solvent, the extraction of the nicotine without the use of an extraction apparatus requiring the application of heat, and the direct titration of the extract without previous distillation. Our process as finally adopted accomplishes all of these ends, as will appear below.

Gasoline or ligroin was chosen as the most suitable solvent. This is prepared by shaking the crude gasoline of 70° with concentrated sulphuric acid and distilling and collecting the distillate coming over between the limits of 60° and 100° C. By using a product with high boiling point, the evaporation which takes place during the filtration of the extract is reduced to a minimum and there is little danger of explosions occurring from the accumulation of the vapors in the atmosphere of the room. A number of preliminary experiments were carried out to determine the conditions necessary for the complete extraction of the nicotine from the tobacco and the effect of varying amounts of ammonia on the results obtained by titration of the extracts.

PRELIMINARY EXPERIMENTS.

In order to avoid the possibility of the presence of organic acids in the extract and to insure the complete extraction of the nicotine, a fixed alkali must be added, and this is best applied in aqueous solution. Gasoline and water are immiscible and their mutual solubility is very slight, but these facts do not in any way hinder or retard the extraction of the nicotine, since the latter is easily soluble in both the water and the gasoline.

It is necessary to agitate the mixture only occasionally to avoid too great a concentration of the nicotine in the portion of either solvent which happens to be in direct contact with the tobacco. Using the ligroin in quantities of 100 c. c. to 6 or 8 grams or less of tobacco, it was found that the extraction of the nicotine is complete at the end of four hours, and when the quantity of the latter in

the tobacco is small less time is required. Ligroin is capable of dissolving only a very small quantity of ammonia gas, and even this is rapidly given off when the solution is exposed to the air, and especially when it is also agitated. It was found by experiment that 100 c. c. of ligroin saturated with ammonia, after being allowed to stand one hour in an unstoppered Erlenmeyer flask, retained less than 5 milligrams of this base. On the other hand we have found that no loss of nicotine whatever occurs when a solution of 0.3 gram of the base in 100 c. c. of ligroin—equivalent to 5 per cent nicotine in 6 grams of tobacco—is allowed to stand several hours in an open beaker at ordinary room temperature. Tobacco, especially after it has been fermented, contains considerable quantities of ammonia, but it was found that only a small proportion of this is contained in the extract; hence the quantity dissolved is not sensibly affected by the varying amounts contained in different samples of tobacco.

This fact is of importance, because it renders the subsequent removal of the ammonia a very simple matter; in fact, even if no attempt is made to remove the ammonia in solution the error resulting therefrom will not exceed 0.2 per cent. In the following table the results given in percentages in column 1 were obtained without the previous addition of ammonia, while those in column 2 were obtained from the same samples after the addition of quantities of ammonia in aqueous solution corresponding to 1.4 and 3.5 per cent, respectively, for 6 grams of tobacco:

Field number of tobacco samples.	1 Nicotine.	2 Nicotine.
	Per cent.	*Per cent.*
13-2-3	3.51	3.53
3-20-2	3.04	3.05

A fair idea of the ammonia actually dissolved by the gasoline is given by the results shown in the following table. The percentages in column 1 were obtained by direct titration of the extracts, while in the case of the first two experiments, the results of which appear in column 2, a current of air was drawn through the extract for five minutes before titrating, and in the last three experiments the solutions were allowed to stand an hour in unstoppered Erlenmeyer flasks before making the titrations.

Field number of tobacco samples.	1 Nicotine.	2 Nicotine.
	Per cent.	*Per cent.*
13-2-3	5.53	3.46
3-20-2	3.09	3.04
123a-1-4	1.92	1.82
123a-1-2	1.86	1.76
3-20-5-12	1.53	1.72

Finally, a number of analyses of different samples were made in duplicate to show that the proposed method gives concordant results even when some of the conditions are somewhat modified, as, for example, when the volume of aqueous caustic soda added to the tobacco before extraction is varied. The tabulated results follow:

Field number of tobacco samples.	1 Nicotine.	2 Nicotine.
	Per cent.	*Per cent.*
75-124, 222	4.90	4.90
75-124, 202	3.92	3.92
125a-1-2	2.00	2.03
123a-1-1	1.95	1.92
123a-1-3	1.88	1.88

DESCRIPTION OF THE METHOD.

From these preliminary data we have been able to work out the details of a very simple method for the quantitative estimation of nicotine which is both rapid and accurate and requires nothing but the simplest forms of apparatus and inexpensive materials.

The air-dried sample is pulverized by passing through a sieve containing twenty or more wires to the inch. For exact work the water content is determined by drying over sulphuric acid for forty-eight hours 1 gram of the sample on a large watch glass placed in a desiccator, while for approximate results the air-dried sample may be assumed to contain 5 per cent of water. Six grams of the pulverized sample are weighed into a beaker, from 3 c. c. to 5 c. c. of 5 per cent aqueous caustic soda solution are added, and the mixture is stirred with a steel spatula until homogeneous. The quantity of caustic soda solution to be used depends on the character of the tobacco to be analyzed; thin, light-bodied samples, such as cigar-wrapper tobaccos, require a larger amount of the solution than do thick, heavy samples, such as domestic cigar-filler types.

The moistened sample is next transferred to a 200 c. c. glass cylinder and 100 c. c. of the ligroin are added. The cylinder is tightly stoppered and the contents thoroughly agitated for a few minutes, after which the cylinder is placed in a horizontal position. This insures the exposure of a maximum amount of surface of the tobacco to the solvent action of the ligroin. Stout glass tubing of suitable diameter and length, sealed at one end and fitted with a good soft cork, serves equally as well as the cylinder for the extraction. After four hours, during which time the contents of the cylinder should be thoroughly agitated at intervals of about thirty minutes, the latter is placed in an upright position in order to allow the upper portion of the gasoline to clarify. After thirty minutes or longer the extract is passed through a folded filter, care being taken to first moisten the filter with the clear portion of the gasoline. The extract is poured

off from the tobacco without bringing the latter on the filter, and further portions are pressed out by means of a glass rod flattened at one end. The filtration should be carried out as rapidly as possible in order to avoid loss from evaporation, and as soon as all the extract can be brought on the filter the funnel should be covered with a watch glass. An aliquot portion of the filtrate—conveniently 75 c. c., corresponding to 4.5 grams of tobacco—is measured into a dry separatory funnel, which is left unstoppered and allowed to stand for about an hour in order to remove the ammonia. As has already been stated, no loss of nicotine is to be feared by this treatment. Instead of allowing the extract to stand in the funnel a slow current of air may be drawn through it for five minutes by means of a stopper supplied with inlet and outlet tubes, the latter of which is connected with a filter pump. After the ammonia has been removed 10 c. c. of fifth-normal sulphuric acid in about 50 c. c. of water are introduced into the funnel and the contents thoroughly shaken. After drawing off the aqueous layer the gasoline is washed twice with small volumes of water and the excess of sulphuric acid titrated with tenth-normal alkali, using cochineal as the indicator.

This method of titrating the nicotine may be modified as follows: The measured portion of the filtered extract is placed in a 250 c. c. Erlenmeyer flask and allowed to stand an hour. The standard acid is then run in and a convenient volume of water added. The contents of the flask are thoroughly shaken, and after the two layers have separated the greater portion of the ligroin is drawn off by means of a pipette.[a] The excess of acid is then titrated as before. One cubic centimeter of fifth-normal sulphuric acid is equivalent to 0.0324 gram of nicotine.

COMPARISON OF THE NEW METHOD WITH THAT OF KISSLING.

As has already been stated, the only reliable method for the determination of nicotine heretofore available is that of Kissling, and we have used this as the standard for comparison. The nicotine content of a large number of samples of tobacco of different types has been determined both by the Kissling process and by the new method, and the figures given in the following table are fairly representative of the results obtained.

It will be seen that the nicotine content in the different samples included in the table varies from 5 to less than 1 per cent, and these samples represent practically all classes of domestic cigar tobacco of both wrapper and filler types. Most of the samples had been fer-

[a] It is necessary to remove the greater portion of the gasoline before titrating because of the yellow coloring matter which it contains in solution.

mented, but some of them were unfermented. All results are calculated on the water-free samples.

Field number of tobacco samples.	Kissling method.	New method.	Difference.
	Per cent.	*Per cent.*	*Per cent.*
75-154,242	5.03	5.02	−0.01
75-154,218	4.70	4.61	− .09
13-2-3	3.66	3.57	− .09
3-20-2	3.18	3.09	− .09
125b-1-4	2.60	2.59	− .01
123a-1-12	2.37	2.27	− .10
124b-1-1	2.19	2.11	− .08
123a-1-14	2.15	2.08	− .07
125a-1-2	2.19	2.03	− .16
123a-1-1	2.00	1.92	− .08
125b-1-1	1.92	1.95	+ .03
123a-1-8	1.97	1.88	− .09
123a-1-3	1.96	1.87	− .09
123a-1-2	1.72	1.76	+ .04
123a-1-9	1.64	1.77	+ .13
125a-1-4	1.64	1.57	− .07
3-20-5-12	1.52	1.53	+ .01
124b-1-6	1.58	1.49	− .09
3-20-5-6	1.32	1.40	+ .08
109-3-4	.89	.94	+ .05

Average difference, 0.04 per cent.

CONCLUSION.

It will be observed that the results shown in the above table indicate that the new method gives figures averaging a few hundredths per cent lower than the Kissling method. This difference is due to the water added to the sample along with the caustic soda, which is not taken into account in the calculations. From 3 to 5 c. c. of water are thus added, depending upon the character of the tobacco. As is well known, tobacco is markedly hygroscopic, and a considerable portion of the added water is doubtless held in loose chemical combination with the salts contained in the tobacco, and hence does not act as a solvent for the nicotine. The portion of the water not thus combined, however, really forms a part of the nicotine extract. It was found by experiment that the relative solubility of nicotine in ligroin and in water is in the ratio of 11 to 9. The mutual solubilities of ligroin and water are so slight as to be negligible, and there is no appreciable contraction in volume when the two are mixed. Taking all the facts into consideration, it is clear that the actual error resulting from the addition of the water to the sample to be analyzed is too small and variable to attempt any correction therefor.

It should be observed in this connection that those types which contain the highest percentage of nicotine belong to the class of heavy filler tobaccos, and hence require the addition of only the smallest quantity of water. This, of course, tends to equalize this source of error. The analyses by the Kissling method were not made in duplicate, and differences in the results obtained by the two methods amounting to one-tenth of 1 per cent or more are doubtless due to slight experimental errors.

After a very careful test of our new process, we are fully convinced that it gives very reliable and accurate results, while it is so simple in execution that there are few chances for the occurrence of errors in manipulation.

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DRY FARMING IN THE GREAT BASIN.

BY

CARL S. SCOFIELD,

AGRICULTURIST IN CHARGE OF WESTERN AGRICULTURAL EXTENSION INVESTIGATIONS.

ISSUED MAY 31, 1907.

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LETTER OF TRANSMITTAL.

U. S. Department of Agriculture,
Bureau of Plant Industry,
Office of the Chief,
Washington, D. C., March 6, 1907.

Sir: I have the honor to transmit herewith and to recommend for publication as Bulletin No. 103 of the series of this Bureau, the accompanying manuscript, entitled "Dry Farming in the Great Basin," by C. S. Scofield, Agriculturist in Charge of Western Agricultural Extension Investigations.

Nearly one-third of the arable land of the United States is either arid or semiarid, and consequently can be used for agriculture only when irrigated or when devoted to such crops as are able to thrive with a limited supply of moisture or such as permit special tillage by which the scanty rainfall may be secured and held in the soil.

Notwithstanding the natural drawbacks of this great semiarid region, which occupies the larger part of the western United States, hardy pioneers have found within it many places where profitable farming is possible, and they have worked out tillage methods and found suitable crops for some sections that were believed a quarter of a century ago to be unfit for anything but stock ranges.

In the present paper Mr. Scofield describes the natural conditions and discusses the farming methods and the crops for one of the sections of this arid region where "dry farming" is now successfully carried on. Some of the more important factors that have made this development possible are shown to be a distribution of the rainfall which is favorable as to season, a clean summer fallow between crops to conserve the rainfall of two seasons where necessary to produce a crop, and the maintenance of soil fertility by good tillage, together with the continued addition of organic matter to the soil. It is shown, also, that while something has been done in the way of using drought-resisting crops, secured either through introductions from other countries or by plant breeding, much still remains to be done in this direction, and that further work along this line, together with still more knowledge as to the efficiency and cost of various tillage methods, promises to greatly extend the boundaries of profitable agriculture in the arid West.

Respectfully,

B. T. Galloway,
Chief of Bureau.

Hon. James Wilson,
Secretary of Agriculture.

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DRY FARMING IN THE GREAT BASIN.

INTRODUCTION.

During the past four or five years much interest has been manifested by the people of this country in the possibility of utilizing for agriculture some of the arable land in the western United States where the rainfall is insufficient for ordinary farming. There are several conditions that have contributed to this interest. American agriculture has enjoyed a large measure of prosperity during recent years and agricultural investment and farm-home development have received an unusual impetus. The choicest of the well-watered public lands have passed into private ownership and have greatly advanced in price.

Then, also, during the last two or three years there has been rather more than the normal amount of rainfall over the larger part of the arid region, and many people acquainted only with the present conditions firmly believe that the climate is gradually becoming more humid. This belief is probably without any foundation in fact, and it is surprising that it should exist, for the precipitation records of the whole country receive wide publicity; but since the idea is generally held and has been widely advertised it becomes important to emphasize the fact that there is no adequate basis for hoping that the climate of the arid West is undergoing any appreciable change as regards precipitation.

Within recent years, also, investigation and experimentation have been directed toward the solution of some of the complicated problems involved in the conservation of soil moisture in these arid regions. Actual additions to existing knowledge of the subject have been relatively few, but public attention has been directed to the work to such an extent that the idea prevails that much more is now possible in the way of utilizing a limited rainfall than was ever possible before. There is some foundation for such a conclusion, but nothing to warrant many of the exaggerated statements now current. The conquest of the arid West, to be successful and to be accomplished without large and costly failures, must be made slowly and by the careful application of definitely ascertained facts. The boundaries of existing

settlements may be gradually extended, but any wholesale attempt to colonize large areas of this arid land with people accustomed to farming only in humid regions or not accustomed to farming at all is almost certain to result in disastrous failure.

The region just east of the Rocky Mountains has already been the scene of some large booms in arid lands. One of the first of these, which occurred from 1880 to 1885, was partly the result of a series of years of relatively high precipitation and partly the result of very extensive railroad building. A series of drier years following drove back many of the new settlers after they had lost all their possessions while waiting for a rainy season to come again. There have since been a number of smaller booms, which have affected different parts of the region at different times, as a result of temporary periods of increased rainfall or some other local cause. One of these, in the two or three years following 1890, began to assume large proportions when the financial crisis of 1893 and the severe drought of 1894 combined to drive back most of the new settlers. As each of these early waves of settlement receded, it left behind some few pioneers, who, by dint of harder work, by the use of better judgment in selecting land, or by turning to stock raising and using as range land the farms of their less persistent neighbors, succeeded in holding out through the dry years.

The region just west of the Rocky Mountains, particularly that portion of it lying within the State of Utah, was first settled by farmers who depended exclusively upon irrigation for crop production. The extensions of their settlements were naturally made along those streams from which the diversion of water for irrigation was possible. These first settlements were made about 1850, and for the next thirty years irrigation farming and stock raising on the open range constituted the only agriculture of the region.

In the decade of 1870–1880, some pioneer attempts were made to grow crops without irrigation in and around some of the valleys of the Great Basin. These attempts finally showed the way to the utilization of large tracts of fertile land for which no irrigation water could be had. The first efforts were relatively few and unimportant, but as the country became more thickly settled and new irrigation enterprises became scarce and expensive more attention was directed to the development of these nonirrigable lands.

This development was begun by growing crops to supplement those grown on the irrigated land. Almost no attempts were made at first to establish farms on the dry lands, so that the first failures, by which the methods of success were learned, were not so disastrous as they might have been had it been necessary to build homes and make other improvements independent of any irrigation opportunities. It is

manifestly much easier to experiment in dry farming, to gamble on the weather as it were, if one has an irrigated farm to fall back upon in adverse seasons. Even where it is possible by the use of windmills or the development of springs or small streams to irrigate relatively small fields during a protracted drought, the settler is able to tide over times when without such a resource complete failure would be inevitable. When the utilization of the dry lands can proceed from well-established agricultural centers, such as irrigated sections, instead of having to start unsupported in the midst of the dry lands, the risk of disastrous failure is greatly reduced.

From the modest and tentative beginnings of a third of a century ago there has grown a well-established system of farming in some sections of the country west of the Rocky Mountains. There are in this great intermountain area three fairly well defined regions in which dry farming[a] is now practiced to a considerable extent. For convenience of designation, these regions may be named the Great Basin, the Columbia River Valley, and the interior valley of California. Each of these areas includes localities with widely differing conditions of soil, climate, and agriculture, and each, taken as a whole, differs from the others in important particulars, yet they have some important features in common not shared by the Great Plains region, which includes most of the arid lands east of the Rocky Mountains.

LOCATION AND GENERAL DESCRIPTION OF THE REGION.

The agricultural region referred to as the Great Basin area (fig. 1) occupies a portion of the great depression between the Rocky Mountains and the Sierra Nevada. To the north of the Great Basin lies the drainage basin of the Columbia River, while to the southward the drainage is collected by the Colorado River. The Great Basin proper is well defined topographically. It includes a large irregular body of land lying chiefly in the States of Utah, Nevada, Oregon, and California, of which the drainage finds no outlet to the ocean, but instead collects in various lakes and sinks, from which it evaporates.

[a] The term "dry farming" is a recent addition to agricultural literature, but since it meets a real need it will probably find a permanent place. There is some difference of opinion as to just what the expression means. It is ordinarily understood to mean farming in an arid or semiarid region without irrigation, but this is often confusing, since "arid" is at best a relative expression and irrigation is often used even in humid regions. All good farming involves at least some tillage of the soil, which accomplishes several purposes at once. The soil is aërated, weeds are killed, the tilth is improved, and moisture is conserved. Sometimes one and sometimes another of these objects is the chief aim, and sometimes all are important. In dry farming, however, the one object of paramount importance is the conservation of soil moisture, and all the tillage operations are directed to this end.

The Great Salt Lake of Utah and a large depression in Nevada, formerly occupied by Lake Lahontan, are the two most important drainage centers, but there are numerous smaller lakes and sinks quite independent of these. In addition to the agricultural land in the Great Basin proper there is a considerable area of arable land lying between the eastern side of the Great Basin and the Rocky Mountains. This constitutes the northern portion of the Colorado River drainage basin, but in view of the similarity of conditions prevailing over this region and the near-by Great Basin it seems proper to include both in a discussion of the agriculture of the section, and in the present paper the term "Great Basin area" is used to include not only the Great Basin proper, but also the region between it and the Rocky Mountains. By far the larger part of the arable land of the Great Basin area lies at an altitude of more than 4,200 feet above sea level. The topography is broken by numerous mountain ranges, so that the arable land is confined to the intervening valleys and wash plains. These wash plains often occur as high mesas, with a gently rolling topography except where they are cut by the courses of streams and recent erosions.

FIG. 1.—Map showing the location of the Great Basin.

The valleys of water courses are now all more or less developed by irrigation, while the higher mesas which can not be reached by gravity canals remain to be utilized without irrigation, if at all.

In the eastern part of the Great Basin area, where most of the dry farming is now done, the valleys and mesas are relatively small. One or two of them are 15 or 20 miles across, but many are only 1 to 4 miles across and of varying lengths. Often they lie between high timber-covered mountains that furnish perennial streams and a timber supply, as well as valuable range land. In other cases they are surrounded by relatively barren hills, which afford neither water nor timber and yield but little range.

In the northern and central portions of this area the higher and better-watered arable lands are covered with sagebrush (*Artemisia tridentata*) with its gray-green foliage. In the swales on the roll-

ing mesas the dark green of the rabbit brush (Chrysothamnus) makes a pleasing contrast in the landscape. Among this shrubby growth various grasses naturally occur, Agropyron, Bouteloua, Stipa, and Bromus being the genera more commonly represented. In a few localities where conditions are favorable these grasses sometimes form a compact sod, but usually they occur in scattered tufts. On exposed situations and along the foothills, cedars of various species occur in scattering groups, usually marking rock outcrops or stony soil. In the lower valleys, particularly in the heavier and salty lands, the greasewood (*Sarcobatus vermiculatus*) replaces the sagebrush as the characteristic shrub, with intermingling grasses or sedges where enough moisture is available and with various saltbushes and saltworts, species of Atriplex and Dondia, where moisture is scant or alkali abundant.

In the southern part of the Great Basin area the sagebrush is replaced on the better lands by the creosote bush (*Covillea tridentata*), while the lower and more alkaline lands are occupied almost exclusively by the greasewood and the saltworts mentioned above. Along the water courses willows and cottonwoods are common, but aside from these the arable lands are treeless and easily brought under cultivation.

EXPERIMENTS IN DRY FARMING IN THE GREAT BASIN.

The first agricultural settlements in the Great Basin were made along the courses of streams, where water could be diverted for irrigation, and apparently for a long time no one thought farming without irrigation possible. As a consequence the early agriculture of the region was confined to relatively intensive irrigation farming and to ranging cattle and sheep on the higher lands. Irrigation farming included the production of most of the staple crops common to American agriculture, but with considerably more emphasis on wheat and alfalfa than on any other crops. According to the census of 1900 the State of Utah had somewhat more than 686,000 acres in specified crops. Of these, about 190,000 acres were devoted to wheat, about 270,000 acres to alfalfa, and nearly 115,000 acres to hay and other forage crops; in other words, nearly 85 per cent of the total acreage was devoted to these crops. Unlike the other irrigated sections of the West, the Great Basin area produces a considerable acreage of oats under irrigation. The area devoted to this crop in the Great Basin in 1899 was slightly more than 43,000 acres, while barley, which is the most important cereal besides wheat usually grown under irrigation in the West, was grown on less than 9,000 acres of Utah land. Corn is grown only to a limited extent, there being reported for 1899 only 11,000 acres, while 10,000 acres were devoted to potatoes and 5,000 acres to miscellaneous vegetables. Sugar beets

and orchard fruits are important features among the agricultural industries of the area. The latter are both intensive crops, yielding high returns per acre. There were grown 7,500 acres of sugar beets and 16,000 acres of orchard fruits in 1899. These areas seem small for a whole State, but it should be remembered that only a relatively small part of the State has yet been utilized for agriculture. There remains much valuable land to be developed, both with and without irrigation. During the decade from 1889 to 1899 the irrigated acreage in Utah increased 138.8 per cent, or from 263,473 to 629,293 acres, and progress has been fully as rapid since, so that these figures may be increased safely by 50 per cent in estimating the present status of the agriculture of the area, and the indications are that the acreage devoted to dry farming has increased more rapidly even than the irrigated acreage.

In the State of Nevada, which lies almost wholly in the Great Basin, there is at present practically no farming without irrigation. The Twelfth Census reports for the State for 1899 a total in specified crops of 328,458 acres, of which 323,352 acres, or all but 5,000 acres, were irrigated. The difference, or unirrigated land, was nearly all in wild hay and probably irrigated naturally by overflow. There are without doubt numerous valleys in Nevada where dry farming is possible, but there is no evidence that any of these have yet been developed.

The portion of Oregon included in the Great Basin is as yet almost entirely without settlements, so that whatever resources it may have in the way of lands adapted to dry farming are still unknown.

Probably the most striking feature of the agricultural practice of Utah farmers is the lack of an intertilled annual crop to be grown in rotation with the cereals and hay. The discrepancy between the combined acreage of the three important intertilled crops (corn, potatoes, and sugar beets) as compared with the cereal and hay crops is very marked, there being only about 30,000 acres of this class of crops as compared with more than 550,000 acres of cereals, alfalfa, and tame grasses, or 1 acre of intertilled crops to 18 acres of the others. This discrepancy shows the acute need of finding varieties of such crops as corn and sorghum that can be used profitably in rotation with the cereals and forage crops, for it is difficult to secure the best results in general farming without the use, at least occasionally, of an intertilled crop in the rotation. This is particularly true in farming without irrigation, for crops that can not be cultivated during the growing season permit the waste by direct evaporation of a large amount of soil moisture, while with crops that can be intertilled there should be but little more moisture removed from the soil than is required by the crop itself.

PRIVATE EXPERIMENTS IN DRY FARMING.

It is not the present purpose to devote much space to an account of the beginning of dry farming in the Great Basin, but it may be said in passing that it was probably first systematically tried in the Cache Valley, near Logan, Utah, about 1870, or shortly before. The first attempts resulted in failure, but in a few years enough had been learned to justify a continuation and even a considerable extension of the practice. The idea seems to have spread slowly at first, and it has been only since 1885, or later, that it has reached any appreciable proportions, even in the Cache Valley, where water for irrigation was until recently ample for the needs of all the settlers.

Within the past two decades, and particularly during the last one, there has been an enormous increase in the acreage farmed without irrigation, until practically all the arable land in this valley is now utilized either with or without irrigation. The Twelfth Census, which gives the acreage of crops grown in 1899, reports a total of 58,658 acres irrigated in Cache County, which includes the Cache Valley and little else, while the total acreage in specified crops for the same year is nearly twice that area, so that for that year the acreage farmed without irrigation nearly equaled the irrigated acreage. The increase in acreage devoted to both kinds of farming has been rapid since 1899, and it is probable that at present there is more dry-farmed land in this valley than irrigated land. In the Bear River Valley and in the valley of the Malade River there is also a large area of dry-farmed land, which is rapidly extending northward and westward.

Along the eastern shore of Great Salt Lake, on the lower benches of the Wasatch Mountains, there are isolated patches of land farmed without irrigation, but in some of these cases, at least, there is probably subirrigation from seepage water. On the foothills of the west side of the Jordan River Valley, between Utah Lake and Great Salt Lake, and also in Utah County east of Utah Lake, there is now considerable dry farming on the higher lands. Much of this is of very recent development.

Directly south of Great Salt Lake, in Tooele County, Utah, there is a broad valley in which dry farming is now practiced to a considerable extent. In the eastern part of Juab County and south of Utah Lake, between Nephi and Levan, there has been a very rapid development of dry farming within the past six years.

The accompanying sketch map (fig. 2), which shows approximately the location of the irrigated land in the State of Utah, may serve to show also the location of the land farmed without irrigation, since it is only around the edges of the irrigated land that dry farming is at present carried on.

In the southwestern part of Utah, in Iron and Washington counties, dry farming is still in the experimental stage, but there are several valleys in these counties where success seems assured if proper methods are followed. In the southeastern part of the State, in San Juan County, there is a high plateau extending eastward into Colorado which probably contains a million acres of arable land adapted to dry farming. (See Pl. II, fig. 2.) This part of the State is difficult of access and is at present but little known.

In addition to the localities mentioned, there are many others in Utah and western Colorado where dry farming is, or may be, successfully carried on, at least supplementary to irrigation, if not independently.

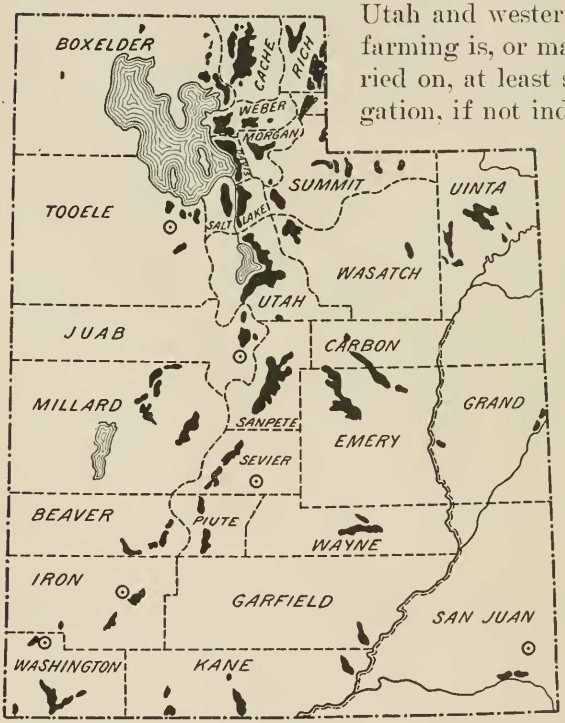

FIG. 2.—Sketch map of Utah, showing the irrigated areas according to the census of 1900 and the location of arid experiment farms.

THE UTAH ARID EXPERIMENT FARMS.

The importance of dry farming as a factor in the development of the State of Utah has been recognized by the people of that State to the extent that the legislature has made direct appropriations to establish and maintain experiment farms for working out scientifically the best methods of tillage and rotation and for testing crops and varieties to find those best suited to local conditions. Six such farms have been established in representative parts of the State; their approximate locations are shown on the sketch map, figure 2. These farms were provided for by an act of the Utah legislature approved March 6, 1903. Each of them contains 40 acres of land, is equipped with the necessary farm machinery, and is well fenced, but has no other improvements. The work is directed by the officers of the State Agricultural Experiment Station at Logan, Utah, while each farm is under the direct charge of a local superintendent. All

the labor required, whether of men or teams, is employed by the day or by the hour from near-by farms. No live stock is kept on the farms.

On each of these farms systematic experiments have been planned with a view to working out some of the more important tillage and crop problems, both general and local. The land is laid off in long, narrow strips, which are subdivided crosswise into plats ranging from one-fifth to one-third of an acre in size. Except for a few experiments, these strips or series of plats are alternately put in crop and given a clean summer fallow. Plate I, figure 1, shows one of these experiment farms with the alternate series in crop and in fallow, while Plate II, figure 1, shows a portion of one of the fallow series and the way the surface mulch is maintained. The plans of the experiments and descriptions of the stations have been published by the Utah Agricultural Experiment Station, and the reports of results obtained are to be published from time to time, as required by the law under which they were established.[a]

These experiment stations, representing as they do a variety of conditions within the State, promise to be of great value in solving some of the problems of dry farming, particularly if they can be continued for a considerable length of time. From the fact that the same general plan of experiments is being followed on each of them, opportunity is offered to get a perspective on the results that would be quite impossible with only one or two such stations. In addition to this, these farms serve in a measure as demonstrations of what can be done and how best to do it in each of the sections where they are located. Such demonstrations are of the greatest value to a community, for the lessons of proper tillage methods for moisture conservation are hard to learn except by costly experiment or continued observation.

LOCAL CONDITIONS WHICH AFFECT DRY FARMING.

From the standpoint of dry farming the most important feature of climate is the precipitation; its amount, its distribution through the year, the variation in amount from year to year, and the way it falls—whether chiefly as snow, as frequent light showers, or as occasional torrential rains. These factors are, of course, all closely interrelated with others, such as temperature, atmospheric humidity, wind movement, and the character of the soil.

The success or failure of dry farming in the Great Basin is largely influenced by local conditions of climate and soil, so that a careful

[a] "Arid Farming in Utah," Bul. 91, Expt. Sta., Utah, January, 1905, and "Memorandum of Plans for Arid Farm Investigations," Circulars No. 1 and 3, Expt. Sta., Utah, April, 1904, and April, 1905.

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investigation of these conditions is well warranted, not only by anyone studying the subject as a whole, but also by anyone proposing to begin such farming in that region. Some of these conditions, such as the character and annual distribution of the rainfall, are much the same for the whole region, but other conditions, such as the actual amount of the rainfall, are largely influenced by the local topography and therefore vary greatly even within a limited area.

PRECIPITATION MAINLY IN WINTER.

In the Great Basin, as in nearly all of that part of the United States lying west of the Rocky Mountains, the larger part of the precipitation occurs during the winter rather than during the summer months. In this respect the climate differs from that of the great semiarid region east of the Rocky Mountains.

Contrary to the generally accepted opinion, there seems to be good reason for believing that more economical use of a limited rainfall is possible when the larger part of it takes place during the winter than when the rains are mostly confined to the summer months. This is particularly true when the rainfall is too light to produce a crop every year, so that summer fallowing or alternate-year cropping is necessary to conserve the scanty supply.

There are several reasons for this. When the rain comes during the cool weather a much smaller percentage of it is immediately evaporated than in warmer periods, so that more of it soaks into the ground. When rain falls on the hot, dry ground in midsummer it takes at least one-fourth of an inch to wet the surface and establish connection with the moist soil below, while on the heavier soils at least one-half inch is needed to penetrate the dry surface. After the rain has ceased a considerable quantity of water evaporates before the surface is dry enough to cultivate, if cultivation is possible, while with standing grain and similar crops the direct evaporation from the soil continues until all moisture within reach of the surface that has not been taken up by the plants meanwhile is lost into the air.

With a favorable soil—a soil with sufficient fine material to have a high water-holding capacity, yet with enough coarse material to permit easy penetration of rain water—the best use of a limited rainfall is possible when it occurs during the cooler months, either as snow or as slow rains of one-half an inch or more at a time, so as to give a maximum of penetration and a minimum of run-off and evaporation. This is, of course, not true for all climates nor for all soil types. Where the winters are long and severe, so that the ground is deeply frozen, winter precipitation would be largely wasted in surface run-off and by evaporation before the ground

thawed out in the spring; while on shallow soils or soils with a relatively small amount of fine material, and consequently a low water-holding capacity, the rain that falls, except during the growing season, is largely lost by percolation to depths beyond the reach of plants.

It is well known that moisture may be lost very rapidly from a soil if the surface is not stirred soon after a rain. It is, therefore, only with intertilled crops that rain can be economically utilized during the hot growing season. For crops that can not be intertilled, such as wheat, oats, and barley, the greatest economy of soil moisture is possible if no rain falls after the crop is sown, or at least after the last surface tillage is given.[a] Where the soil is fairly heavy and deep it can hold available sufficient moisture to mature any ordinary crop, provided losses by direct evaporation are nearly or quite prevented.

The growing season of the ordinary crop plants is set within fairly definite limits. If moisture is not supplied at about the time it is needed, the plants either die outright or are injured beyond recovery. In farming with a limited rainfall there is therefor much less risk involved where it is possible to store in the soil during a whole year enough water to carry a crop to maturity than where it is necessary to depend on the chances of rains at just the proper time during the growing season. There is much less chance of a year-long drought than of a drought of two or three weeks during the summer when rain is badly needed for crops.

In figure 3 is shown the average monthly precipitation at four representative points in the eastern part of the Great Basin, while for purposes of comparison similar diagrams are shown of the precipitation at four representative points in the Great Plains area which lies on the eastern slope of the Rocky Mountains. The diagrams are arranged to show the average amount of precipitation in inches of water for each month in the year, and the months are arranged in the order of the calendar year, with January on the left and December on the right.

It may be seen at a glance that the seasonal distribution of the precipitation is strikingly different in the two regions represented. In the Great Basin the larger part of the rain falls in the autumn, winter, and early spring, while except at Parowan[b] the midsummer rainfall is almost negligible. On the other hand, the characteristic

[a] In the case of autumn-sown cereals it is not only practicable but decidedly advantageous to harrow the crop in the spring as late as it can be done without injuring the grain.

[b] Parowan is evidently far enough south to share somewhat in the torrential summer rains that often occur in Arizona and New Mexico.

feature of the Great Plains climate is its relatively heavy summer rainfall and its dry winters.

ANNUAL VARIATION IN RAINFALL.

There are no rainfall records covering long periods of time for the places in the Great Basin where dry farming is now attracting the most attention. The earlier settlers were interested chiefly in irrigation farming and gave but little attention to rainfall. With few exceptions such records as are in existence have been made in cities or towns that were located with reference to irrigation or transportation facilities rather than in representative agricultural regions, and consequently the available records are of limited agricultural applition.

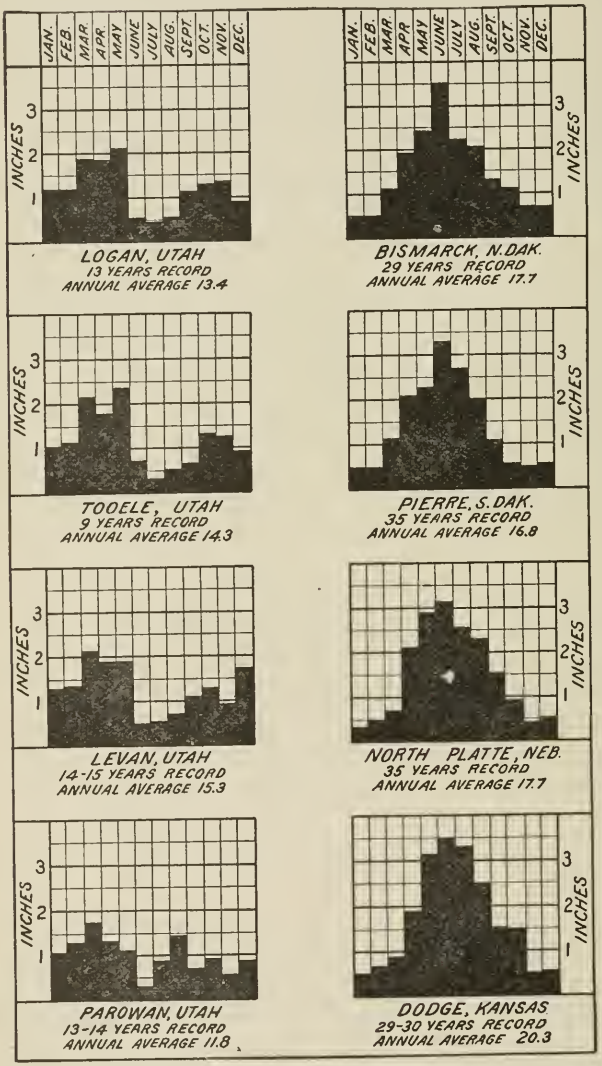

FIG. 3.—Diagrams showing the average monthly precipitation at some representative points in the semiarid West.

The following charts show the total annual precipitation at four places in Utah where dry farming is now carried on to some extent. In fact, the two towns Logan and Levan probably represent the best and most extensive development of dry farming in that region. Such records as these are valuable in proportion to their length, for when long continued they furnish a basis for interpreting present conditions without which wrong judgment would be almost certain.

Logan, Utah, is situated near the northern boundary of the State, near the eastern side of the Cache valley, in which dry farming has been carried on for nearly a third of a century, and it is now probably the most important dry-farming section in the State. Except on the eastern side the valley is surrounded only by low hills, so that the rainfall is probably very evenly distributed over it. The record shown in the diagram (fig. 4) covers a period of fourteen years, from 1893 to 1906, inclusive, the annual average being 15 inches. It will be noted that for the period of record previous to 1906 the variation from the mean was slight, but in 1906 the amount of rain was nearly double what it was in 1905.

Tooele, Utah, is situated near the eastern edge of a broad valley directly south of Great Salt Lake. This valley, which lies at an altitude of about 4,500 feet, is one of the largest in the State in which dry farming is possible. The region around Tooele has not been used for dry farming until within the last three or four years. Records are available for the last ten years only. The annual average for that time is 15 inches, while the extremes range from about 10 inches to slightly over 20 inches. (See fig. 5.) It will be noted in this case, also, that the rainfall during 1906 was the greatest recorded, although the difference is not so marked as in the record for Logan.

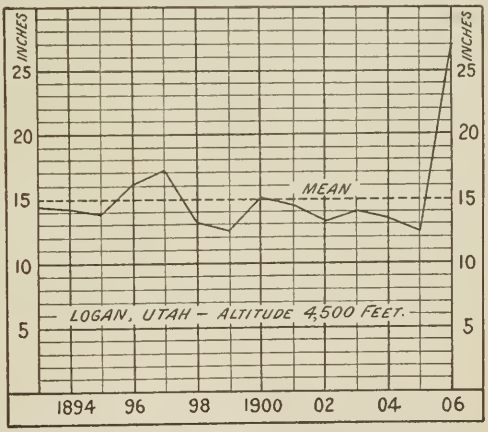

FIG. 4.—Diagram showing the total annual precipitation at Logan, Utah, 1893–1906.

Levan, Utah, is situated in a comparatively narrow valley in the central part of the State, a short distance south of Nephi. This valley is in one of the older settled sections of the State, and since 1900 it has been the scene of very rapid development of dry farming. This record also shows an unusually large rainfall during 1906, which was exceeded only in 1895. (See fig. 6.) It is clear from such a record as this that frequent crop failures can be avoided only by tillage methods by which a reserve of moisture is stored in the soil for the use of crops during the drier years.

Parowan, Utah, is situated near the southern part of the State in one of the smaller valleys east of the Escalante Desert. The annual average for the fourteen years recorded is 12.5 inches, while the extremes range from 21 inches as the highest to 7 inches as the lowest.

In this case, again, the unusual rainfall of 1906 is shown. It becomes apparent from a comparison of this (fig. 7) and the preceding diagrams that the rainfall of 1906 was much above the average in the Great Basin. The relatively large rainfall of 1906 has stimulated local interest in dry farming in a way that nothing else could do.

The wonderfully large crops obtained during the last season without irrigation, together with the recent unusual interest in dry farming, have combined to convince the local public that irrigation is rapidly becoming unnecessary in that region. In fact it is not generally realized how much more rain there was during the last year than usually falls. It is true that the present agitation in favor of dry farming in Utah was actively begun in 1902 and 1903, when the rainfall was rather below the average, so that while the greater rainfall of last year has probably encouraged unwarranted hopes as to what can be done without irrigation, yet the actual extension of farming has doubtless been much greater than it would have been without the increased rainfall. There can be no doubt that there will soon be drier years again, for the records of rainfall show no reason for believing that the climate is changing.

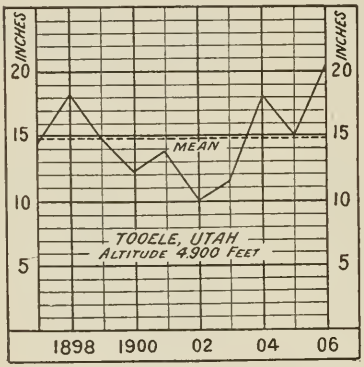

FIG. 5.—Diagram showing the total annual precipitation at Tooele, Utah, 1897–1906.

INFLUENCE OF LOCAL TOPOGRAPHY ON RAINFALL.

The air currents that bring rain into the Great Basin come mainly from the west, saturated with moisture from the Pacific Ocean. A large part of this water in the lower atmosphere is precipitated as this air passes over the high Sierra Nevada range, but enough moisture is soon recovered either from the upper air or from the earth for each of the successive mountain ranges in the Great Basin to receive its share of rain, the amount in each case increasing with the height of the ranges and their distance apart. Thus, just as the western part of the Great Basin is more arid than the eastern part, so the western side of each valley in the Great Basin is drier than the eastern side; or, conversely, the western slope and foothills of a mountain range receive more rainfall than the eastern slope, the difference depending somewhat upon the height of the range. (See fig. 8.)

The following table illustrates this phenomenon. The town of Deseret lies well out in a broad valley which is much too dry for any

farming except with irrigation. About 30 miles southeast of Deseret is the town of Fillmore, which lies close to the western slope of a mountain range, the crest of which is 10,000 feet above sea level. In the first part of the table is shown the total annual precipitation at Deseret and Fillmore for all the years for which there are records, and also the difference in favor of Fillmore due to the effect of the mountains.

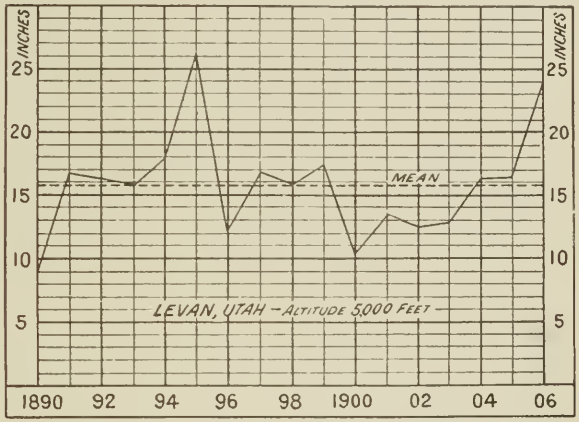

FIG. 6.—Diagram showing the total annual precipitation at Levan, Utah, 1890-1906.

In the second part of the table Fillmore is compared with Richfield, which is only 16 miles away, but on the opposite side of the mountain range. Here also all the available records for both places are given. In this case the difference is even greater than is shown in the first case. Such facts show plainly that it is useless to estimate the probable rainfall at any place in this region where records have not been kept unless the topography is well known and direct comparison is possible with a similar location where the facts are known.

TABLE I.—*Differences in total annual precipitation between points in Utah located near each other, arranged to show the influence of topography.*

Year.	Deseret and Fillmore.			Fillmore and Richfield.		
	Deseret (altitude, 4,600 feet).	Fillmore (altitude, 5,700 feet).	Difference in favor of Fillmore.	Fillmore (altitude, 5,700 feet).	Richfield (altitude, 5,308 feet).	Difference in favor of Fillmore.
	Inches.	*Inches.*	*Inches.*	*Inches.*	*Inches.*	*Inches.*
1893	7.6	15.6	8.0	.....	.....	.....
1894	8.0	13.4	5.4	.....	.....	.....
1898	.....	.....	.....	14.6	4.5	10.1
1899	.....	.....	.....	14.5	8.3	6.2
1900	5.4	9.3	3.9	9.3	1.8	7.5
1901	9.0	12.9	3.9	.....	.....	.....
1902	4.8	11.9	7.1	11.9	6.6	5.3
1903	7.0	12.0	5.0	.....	.....	.....
1904	7.1	12.1	5.0	12.1	5.2	6.9
1905	9.7	16.1	6.4	.....	.....	.....
1906[a]	10.5	20.0	9.5	20.0	6.6	13.4
Average	7.7	13.8	6.1	13.7	5.5	8.2

[a] July records missing.

METHODS OF INTERSEASON TILLAGE.

The methods of farming now in use on the dry lands of the Great Basin area are largely the results of private experiments, and consequently they possess some local peculiarities. It should be kept in mind that there are some unusual features of climate and soil in this region, such as the relatively light summer rainfall and a deep heavy soil that holds large quantities of water.

Deep plowing, frequent cultivation, and alternate-year cropping have been used in retaining soil moisture. Wheat sown in the autumn has been the chief crop grown on the dry lands, and for this reason the land is plowed in the late summer as soon as possible after the crop has been removed. The land is left in the rough furrow all winter, and as soon as the winter rains have either soaked in or dried off, surface cultivation is begun. This cultivation is done chiefly with a disk harrow, though other implements are also used. Sometimes a shallow summer plowing is given to kill and turn under any weeds that have escaped the lighter cultivation. In the late summer the spike-toothed harrow and other smoothing implements are used to prepare a fine seed bed, and the next crop is sown in September or early in October. Since the winter rains compact the soil and get it into such a condition that the direct loss of water would be easy, it is often found desirable to lightly harrow the wheat crop in the early spring, for after it starts to grow nothing more can be done toward preventing the loss of water until after harvest. Since wheat growing involves only the simpler farm operations, which may be performed on a large scale, there have been special inducements to use large machinery and to economize the use of men.

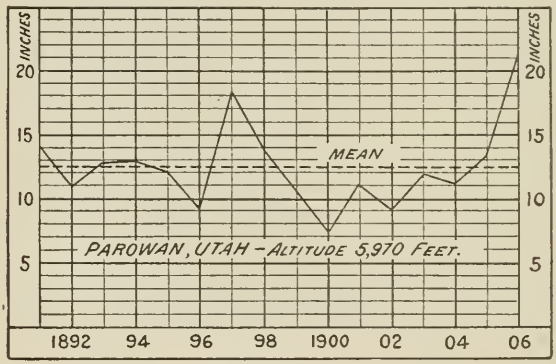

FIG. 7.—Diagram showing the total annual precipitation at Parowan, Utah, 1891–1906.

Large gang plows and large harrows are in common use, and the grain header is used almost exclusively in harvesting the crop. In a few cases steam is used as motive power for plowing, and apparently with success. Where used it is always with a traction engine, which draws the plows behind it instead of working with a cable and operating from both sides of the field.

No reliable data are at hand for estimating the relative cost of

using steam and animals for plowing. The steam outfit requires a large initial investment, and can hardly compete with animals except where there is so much land under cultivation that it can be used a large part of the time.

Aside from the ordinary moldboard plow, the disk plow is extensively used in dry farming in Utah. The disk plow can be employed in plowing land when it is dry and hard, which is highly important, and it also pulverizes the furrow slice when the land is dry rather better than the moldboard plow. The disk plow can also be used in large gangs, and thus works very well behind a traction engine. For summer fallow plowing a light disk plow in gangs is very popular. Such a plow is about half way between an ordinary disk plow and a disk harrow. It cuts about 4 or 5 inches deep and turns the furrow sufficiently to cover any weeds or trash.

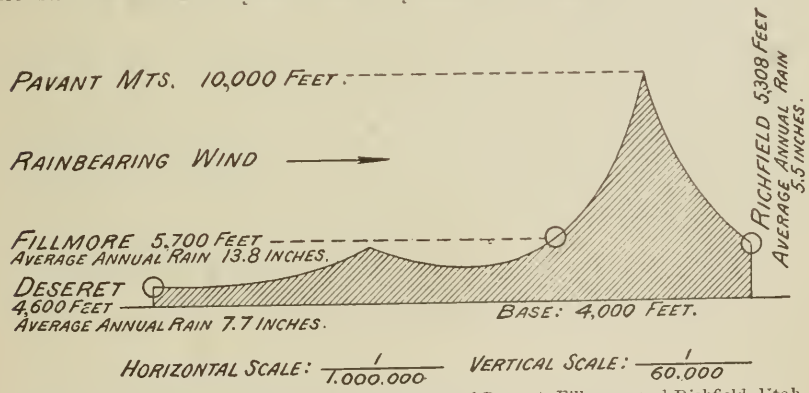

FIG. 8.—Profile sketch showing the relative positions of Deseret, Fillmore, and Richfield, Utah.

Where subsoiling is practiced, the use of a subsoiling attachment in a gang plow is found to be not only practicable but preferable. One very satisfactory disk gang plow that is made for use with five or six horses has two large disks for general use, but when subsoiling is to be done the front disk can be removed and a subsoiler attached in its place. This position of the subsoiler has several advantages. It leaves a smooth-bottomed furrow for the furrow horses to walk in and it also immediately covers the subsoil that is loosened by the subsoil plow, thus preventing a considerable loss of moisture that might result from leaving this loosened subsoil exposed to the air until the next round of the plow. There is some question as to whether subsoil plowing is worth what it costs, and many farmers are of the opinion that deep plowing without subsoiling is the better practice.

The ordinary disk harrow is, of course, in very general use, not only for pulverizing the soil in preparing a seed bed but also to maintain the clean fallow which is so essential to success in this type of farming

The spike-toothed harrow is also used almost universally, not only as a supplement to the disk harrow but also to kill weeds and break the surface crust after rains.

In addition to the smoothing harrow for finely pulverizing the surface soil, some farmers have used with advantage a plank drag, usually of home construction, made of three or four planks fastened together rigidly, one behind another, and with the edges overlapping like the weatherboards of a house. This implement crushes the hard lumps and tends to level the land at the same time. For still further smoothing and pulverizing the seed bed a brush harrow is sometimes used. This, too, is of home construction. It is made of brush rigidly fastened to a plank or log in such a way that the loose ends of the brush bear on the soil, acting much like a coarse broom. This brush harrow, when used after a plank drag, leaves the surface soil in excellent tilth.

For preparing new land for the plow, some sort of implement is often needed to remove the sagebrush. For this purpose a common railroad rail is often used, with a team hitched to each end and the rail dragged sideways across the land, breaking down the brush. This may be followed by a heavy rake, which gathers up the loosened brush into piles or windrows for burning. Several other implements have been devised for removing sagebrush, among them a heavy form of revolving hayrake, which breaks down and partly collects the brush in one operation.

MAINTENANCE OF A CLEAN SUMMER FALLOW.

The term "summer fallow" is used with different meanings in various parts of the country. In the Great Plains area, especially in the northern part, it is applied to the practice of letting the land lie idle and permitting the growth of weeds during the spring months, so that a plowing in June will not only kill these weeds but by turning them under add some much-needed humus to the soil. This June plowing also brings to the surface more weed seeds, which soon germinate and may be destroyed subsequently either by surface tillage or by fall plowing. The chief object of the summer fallow as used in the Great Plains area is rather to free the land from weeds than to conserve the moisture. In other sections of the country the term "fallow" is applied to the practice of leaving the land entirely undisturbed either for the whole or a part of the year. In the Great Basin, however, the summer fallow is used chiefly for moisture conservation.

As has been pointed out, the bulk of the precipitation of this region comes in the autumn, winter, and spring months, the summer months being almost free from rain. It is therefore possible to establish early

in the season a very effective dust mulch on the surface of the soil, which is not likely to be disturbed by summer rains and which requires only enough cultivation to keep weeds from growing. (See Pl. II, fig. 1.) The maintenance of this surface mulch is an expensive operation even under these conditions, for weed seeds germinate readily in the moist soil below the surface, push up through the dry mulch, and unless quickly killed dissipate large quantities of valuable soil moisture. It is quite as important to keep weeds from developing to any considerable size as it is to maintain a surface mulch that will check direct evaporation. If these weeds are killed at short intervals by light surface cultivation they use but little water, and it is also much cheaper to destroy them when small than after they have grown to considerable size.

It must always be taken into account that the surface soil mulch, which is so necessary to moisture conservation, is possible only where the soil is sufficiently heavy not to be blown away by summer winds. These summer winds, which in some regions are almost continuous and sometimes of high velocity, often make a clean summer fallow altogether impracticable. It is also extremely doubtful if the requisite summer fallowing is practicable on very light soils, for even the milder summer winds would do serious damage where such a soil in a fine state of tilth is exposed.

THE IMPORTANCE OF SOIL TEXTURE.

The water-holding capacity of a soil depends largely upon its physical texture and is also influenced to some extent by the amount of organic matter present. For instance, a heavy clay soil containing a large amount of humus might hold 30 per cent of water and still be in workable condition, while sandy soil having 10 per cent of water might seem very wet. It is therefore obvious that where success in dry farming depends upon the storage in the soil within the reach of plants of enough water to carry a crop to maturity, the water-holding capacity of the soil becomes a matter of the first importance.

TABLE II.—*Increased moisture occasioned by 1 inch of rain distributed through various depths of soil, weighing 85 pounds per cubic foot.*

Depth of distribution.	Proportion of moisture.	Depth of distribution.	Proportion of moisture.
Inches.	*Per cent.*	*Inches.*	*Per cent.*
1	75	24	3.1
3	25	36	2
6	12.5	48	1.5
12	6.2	60	1.2

A cubic foot of heavy loam soil perfectly dry is estimated to weigh 85 pounds. A cubic foot of water weighs about 62½ pounds.

The water required to cover 1 square foot to the depth of 1 inch weighs about 5⅓ pounds, while an acre-inch of water weighs about 113 tons. One per cent of moisture per cubic foot of soil is equivalent to 0.84 pound of water, while 1 per cent per acre-foot of soil equals about 18 tons of water.

The preceding table shows the relation between rainfall and soil moisture as stated in percentages. These figures are useful in computing the potential effect of rains of various amounts, assuming that all of the rain enters the soil.

Estimating that a wheat crop, for instance, can use moisture 5 feet deep in the soil, it will be seen that a sandy soil would be able to hold available only about 540 tons of water per acre, while a heavy loam would hold available about 1,350 tons per acre, or a difference of more than 800 tons of water per acre in favor of the heavy soil. These figures show the importance of selecting only the heavier soils for dry farming where the storage of water from one season to another is necessary.

Under their virgin conditions the heavier and better soils of a semiarid region are rarely wet to a depth of more than 3 or 4 feet—often 2 feet or less. With the surface soil undisturbed so that this moisture can move upward and dissipate by direct evaporation, and with the natural vegetation using large quantities, it is only a short time after the rains cease before all the available water is lost from the soil. If this same land is broken by the plow to a depth of 5 or 6 inches, more of the rain water or melting snow soaks into it and penetrates far below the limit of virgin conditions. If, in addition to the first plowing, the surface soil is stirred frequently, a surface mulch is formed which is nearly as effectual in checking direct evaporation as a coat of oil on the surface of water. The moisture thus held in the soil continues downward, wetting soil that in some cases has not been wet for centuries. Since the total annual rainfall in many dry-farming regions is less than 15 inches, of which but little more than half can be secured and held even under favorable conditions, there is ample storage capacity in deep and heavy soils for all the normal rainfall of two years.

In short, the soil of a semiarid region may be regarded as a reservoir which under natural conditions is shallow, with a surface difficult to penetrate and favoring the quick loss of water by evaporation. Under proper methods of tillage the reservoir may be greatly deepened and provided with a cover that will effectually prevent evaporation, so that its supply may be held for the use of crop plants. It is the aim of interseason tillage to accomplish this result. With crops that do not permit intertillage during the growing season the

importance of interseason tillage becomes very great, while the extensive use of intertilled crops lessens the need of it materially.

CROPS AND CROP TILLAGE.

Wheat and alfalfa are practically the only crops grown without irrigation in the Great Basin and, of the two, wheat is by far the more extensively grown. Other cereals, such as oats, barley, and rye, are grown in an experimental way, while such intertilled crops as corn, sorghum, potatoes, and field peas are also being tested to a limited extent.

There are several varieties of wheat in common use both on the dry lands and under irrigation. In fact, there has been but little attempt to develop strains or varieties especially for the dry lands. With a few exceptions, the wheats grown are fall-sown varieties of bread wheat (*Triticum aestivum*). They are nearly all light colored and belong to the class known commercially as "soft wheats." The more popular varieties are known locally under the names of Loft-house, Kofoid, and Gold Coin.

On the State experiment farms a number of varieties of durum wheat (*Triticum durum*) have been under experiment, together with some of the spring wheats of the type grown in the upper Mississippi valley, such as Fife and Bluestem, and also some varieties of the hard, red winter wheats, such as are commonly grown in Kansas and Nebraska. These varieties are all regarded as still in the experimental stage, and they have not yet found their way into general use among farmers.

Alfalfa is the standard forage crop of the Great Basin area, as it is of the entire western United States. Among the people of Utah it is known universally as "lucern," the name under which it was first brought into the Eastern States, and which is derived from the common European name for the plant. This name was probably carried westward to Utah by the early pioneers, who never accepted the Californian name "alfalfa," which has been derived through the Spanish from an Arabic word signifying "the best fodder."

Alfalfa was first grown in the Great Basin only under irrigation, but recently it has been tested rather extensively on the dry lands. Apparently there has been no very serious effort made to secure varieties especially adapted to these dry lands, but instead seed from the irrigated land is harvested and put on the market, together with any seed that may be grown on land without irrigation.

The indications are that valuable drought-resistant varieties of alfalfa could be developed in a very short time if proper attention were given to selecting seed from individual plants or even from some whole fields that appeared to thrive well on a limited supply of

moisture. It is true that a large proportion of the alfalfa seed now produced in this region receives very little, if any, irrigation, since a larger seed crop results when the plants are kept rather drier than is required for the best growth of forage. There needs to be a way devised by which it will be practicable to find recognition in the market for seed of alfalfa that is particularly drought resistant, as distinguished from seed of alfalfa that yields well only under liberal irrigation. If such recognition could be had, there would be an incentive for saving seed from the more drought-resistant plants or fields.

There are practically no grass crops grown on the cultivated dry lands of the Great Basin except in an experimental way. The experiment farms referred to are carrying on extensive trials with a number of promising grasses, including species of Bromus, Agropyron, Lolium, and Elymus. There are some indigenous species, particularly of Agropyron and Elymus, that are giving some promise under cultivation.

There is some doubt as to whether any of these grass crops will ever occupy an important position in dry farming, since they are nearly all shallow rooted and can therefore reach but a small part of the available soil moisture when it is really needed; and, furthermore, they are not well adapted to growing with intertillage or surface cultivation of any kind, whereas such cultivation is decidedly essential for crop production on these western dry lands.

TILLAGE FOR WHEAT.

On the dry lands of the Great Basin it is a common practice to grow wheat after wheat on the same land, sometimes continuously year after year and sometimes with alternate fallow years or with only an occasional fallow year, depending somewhat upon the moisture condition of the soil. The ideal method of wheat farming and the one that appears to be the most profitable, all things considered, is the method of growing a crop every alternate year, with a year of clean summer fallow intervening. In this case the land is plowed deep, about 7 or 8 inches, very soon after harvest, or, if owing to a press of other work it is not possible to plow at once, the stubble is disked as soon as the grain is cut. The grain is usually harvested with a header, so that there is always a large amount of straw to plow under. During the following summer clean cultivation is given the land and wheat is sown again the following autumn.

If, as is often the case, the wheat is overripe when harvested, a considerable quantity shells out of the heads and falls to the ground, so that if the autumn rains come early and this wheat starts to grow there is always a strong temptation to leave the land unplowed. Not infrequently this volunteer wheat does very well and yields a good

crop. (See Pl. III, fig. 1.) There are also cases where this first volunteer crop is allowed to reseed itself, but the resulting crop rarely amounts to much, owing to the irregularities of the stand and to the growth of weeds that quickly establish themselves under such conditions. In the long run, it is doubtful whether it ever pays to grow three or even two crops of wheat in succession without plowing the land between crops, for such practice not only wastes valuable soil moisture, but allows the land to become very weedy. (See Pl. III, fig. 1.)

TILLAGE FOR ALFALFA.

The young alfalfa plant is as tender and delicate as the well-established plant is strong and hardy, so that while it is necessary to have the land in excellent tilth and all other conditions favorable for starting this crop, a well-established field may be harrowed and disked, and sometimes even plowed, without destroying or even injuring the plants. In fact, surface cultivation when the plants are nearly or quite dormant, as in the early spring, seems to actually improve the stand and invigorate the growth.

The best results with alfalfa on the dry lands of the Great Basin are secured by early spring sowing with a drill on land that has been previously put in excellent condition of tilth. The seed is usually sown without a nurse crop, and the land should be as free from weeds as possible, for when the alfalfa plants are young they may be easily injured by weeds. During the first summer the new alfalfa field gets no attention except possibly a clipping with a mower set high to cut any rank weeds that may have started and to cut back the taller alfalfa plants. The plants cut down are usually left on the ground to form a mulch. The second summer the alfalfa field is in full bearing and may be cut once for a hay crop, and, if conditions are favorable, enough second growth will be made to give a light second crop.

When seed production is the aim of alfalfa growing, a light hay crop is usually cut very early, before the plants are in bloom, and the second crop is then the larger and sets seed freely. With alfalfa seed at its present price, seed production on the dry lands is much more profitable than the hay crop unless hay is very scarce and high priced.

After the second year a field may be disked and harrowed with impunity without injuring the plants, so that it is quite possible to materially aid in the conservation of soil moisture in alfalfa fields even if the ground is thickly covered with plants. On the dry lands of North Africa it has been found profitable to sow alfalfa in rows and cultivate it from time to time, and even to grow a wheat crop in alternate years without injuring the alfalfa, which would yield fair crops

of hay during the fallow years.[a] It is reasonable to believe that similar results might follow attempts to grow alfalfa as an intertilled crop, either with or without wheat in alternate years, in the Great Basin, where conditions are in many respects similar to those in the higher lands of North Africa in the vicinity of Setif, where this method of growing alfalfa is in common practice. The quick response of alfalfa to cultivation is shown in Plate II, figure 2, which is reproduced from a photograph taken in the interior of a dry-land alfalfa field some weeks after the first crop of the season had been cut. The plants along the edge of the field next to the surface-tilled land had made a good second growth, while the plants in the interior of the field, where the available moisture had been exhausted by the first crop, had made practically no second growth.

There seems good reason for believing that sowing alfalfa in rows far enough apart to permit intertillage would be a profitable method on the dry lands, even for forage production, while for seed production it would almost certainly be more profitable. It is well known that isolated alfalfa when allowed to mature on these dry lands produces relatively large quantities of seed. This is probably due, in part, to a better illumination on all sides of the plant, resulting in a larger number of flowers; in part to the drier air surrounding these flowers during the pollinating period, which appears to have some bearing in seed production, and in part to the greater ease of access for insects of various kinds that promote pollination. It is certainly true that the partial isolation of the plants secured by row planting results in greatly increased yields of seed per plant, and there is strong probability that the yields per acre would be larger, so that experiments to determine this point would be well justified.

There is a strong tendency in the Great Basin, as elsewhere in the western United States, to let alfalfa grow in a field as long as it will, which is usually much longer than it is yielding its best returns. In other words, it is not used as a rotation crop, in the ordinary sense of the word. The beneficial effect of alfalfa upon the crop that follows it is generally recognized, but a well-established alfalfa sod is hard to subdue for the following crop, while alfalfa seed is expensive, and it is not easy to get a good, even start on a new field. The temptation is very strong, therefore, to leave alfalfa fields undisturbed, even though the increased yields of succeeding crops are much desired.

THIN SEEDING ESSENTIAL TO BEST RESULTS.

Under ordinary conditions in a humid region or with irrigation, farmers sow about 5 pecks of wheat or 75 pounds per acre, and from 15 to 20 pounds of alfalfa seed per acre. On the dry lands of the

[a] Bul. 72, Part I, Bureau of Plant Industry, U. S. Dept. of Agriculture.

Great Basin, however, experience has shown that much better crops of wheat result when only 3 pecks of wheat or 45 pounds per acre are sown, while with alfalfa about 8 pounds of seed per acre gives the best results. Some farmers even sow 35 pounds of wheat per acre without apparently decreasing the yield, and careful experiments have shown that even less than 8 pounds of alfalfa seed per acre will give a good crop if evenly distributed, but uniform distribution is difficult with much less than 8 pounds of seed per acre. The beneficial effects of thin seeding are very striking, particularly in the drier years, when a seeding of 75 pounds of wheat results in crop failure, while a seeding of 35 pounds gives a good crop. This apparent anomaly is due to the fact that the heavier seeding results in so large and sudden a demand for soil moisture that the supply within reach is exhausted while the plants are still in the active growing condition and before the seed is formed, while with thin seeding the same amount of soil moisture is sufficient for the plants produced. Both wheat and alfalfa are able to throw out numerous branches from the central stem, so that when moisture conditions are favorable the number of stems actually produced may be nearly as great from thin seeding as from thick seeding.

THE SUSTAINED PRODUCTIVENESS OF DRY-FARMED SOILS.

In a system of farming where wheat is grown continuously, that is, not in rotation with other crops, such as is the case on the dry lands of the Great Basin, the question of maintaining the soil fertility is a natural and important one. It is ordinarily assumed that the continuous production of any one crop, and particularly such a crop as wheat, must rapidly reduce the fertility of the soil. It would seem, however, that with the tillage system for wheat, previously described, by which a clean summer fallow is given every second or third year and a large amount of straw is plowed under after each crop, the reduction of fertility is by no means so rapid as it is in some other regions and under some other conditions.

As a matter of fact, there are fields in some of the older settled valleys in the Great Basin that have been producing wheat every other year for a third of a century without showing any signs of depleted fertility. (See Pl. III, fig. 2.) While actual comparison is of course impossible, there are reasons for believing that some of these fields are capable of producing better crops now than when first plowed. If this be true, it is important to discover the causes involved and to determine whether this tillage method, if it be found a contributing cause, is capable of wider application with a hope of similar results. It must be kept in mind that in the practice followed on these dry lands, where the grain is headed rather than cut with

the binder and where a large amount of straw is plowed under and incorporated with the soil, there is probably no reduction of the humus content; in fact, there might even be an increase of the humus under this practice, for the soils in their native condition bear but scanty vegetation, which probably adds organic matter to the soil very slowly.

With this large amount of wheat straw plowed under in the autumn and allowed to lie over the next winter, followed by continued surface tillage, conditions appear to be very favorable to the growth of any bacteria that might aid the conversion of this straw into available plant food. In fact, the conditions under which this surface mulch is maintained seem to be particularly favorable for the activities of nitrifying and other soil-enriching bacteria. It is well known that there are bacteria that under favorable conditions work on the complex proteids in the organic matter of the soil and change them into available plant food in the form of nitrates. In addition to these so-called nitrifying organisms, there are known to be other forms of bacteria that while living chiefly on the decaying nonnitrogenous organic matter of the soil are able to utilize and fix atmospheric nitrogen in much the same way as do those bacteria that live and develop nodules on the roots of some leguminous plants.

THE HEAVY SOILS NOT LEACHED.

The heavier soils such as have been found best suited to dry farming in the Great Basin have such a high water-holding capacity that with the ordinary light rainfall of the region there is no cumulative downward movement of water through them. In other words, the rain water that enters these soils is held by capillary force against the force of gravity, and instead of moving downward to join an underground water table, it is returned to the air either by direct evaporation from the soil surface or by transpiration processes through plants. This is, of course, not true for any but the deeper and heavier soils. Soils that occur as thin layers over impervious material, or those with so coarse a texture as to have a very low water-holding capacity, can not act as effective storage reservoirs. This fact again indicates the desirability of heavy soils for dry farming.

The importance of the fact that some of these dry-farmed soils are not leached by the rain water becomes apparent when it is realized that the soluble salts that result from the ordinary processes of soil weathering and from the activity of various organisms are not washed out of the soil, but remain to be used by plants. The proverbial richness of so-called arid soils, as well as the occurrence of alkali in soils of dry regions, is due to the fact that such soils are not leached by the rain.

THE IMPORTANCE OF ORGANIC MATTER IN THE SOIL.

A continued supply of organic matter in the soil appears to be absolutely essential to successful crop production. It is one of the most important sources of the various forms of nitrogen available to crop plants, and nitrogen in some combined and available form is of course absolutely necessary to plant growth.

Undecayed organic matter is not only useless to plants, but it is also likely to have an injurious mechanical effect upon the soil, at least in a dry region, by keeping it loose and open, thus making moisture conservation difficult. The processes of decay that take place in the organic matter in the soil are varied and complicated. Some of them result in additions to the supply of soluble salts used by plants, while others lead to the complete loss of the constituent substances through their reduction to gaseous forms and diffusion into the air, as in oxidation and denitrification. It therefore becomes important to consider something more in a tillage method than merely adding raw organic matter to the soil. This must be followed by providing conditions in the soil favorable to the activities of those organisms that reduce the organic matter to forms available for plant nutrition with as little waste or loss as possible.

CONDITIONS FAVORING NITRIFICATION.

The processes that result in the decomposition of organic matter in the soil and in the formation of nitrates are favored by a moderate supply of oxygen, the presence of capillary moisture, fairly high soil temperatures, and the presence of free bases to combine with the nitric acid formed. Such conditions are very well provided by the method of tillage used in growing wheat in the Great Basin, as previously described. With that tillage system a large amount of wheat straw with its partially decayed leaves is turned into the soil in the early autumn. The winter rains penetrate the loosened soil, and the continued surface cultivation during the following summer largely prevents the loss of this moisture by evaporation. This surface cultivation also promotes the aeration of the soil, which is essential to the most rapid nitrification, while the absence of plant growth to shade the soil gives the high temperature needed.

The beneficial effects on nitrification processes of the conditions produced by summer fallowing are discussed at some length by Hall[a] in describing the work at Rothamsted, England, where the rainfall is sufficient to leach the soil of the field under experiment:

> It will be seen that the produce of wheat after fallow is considerably higher than when it is grown continuously—17.1 against 12.7 bushels per acre; but if

[a] Hall, A. D. The Book of Rothamsted Experiments, pp. 62–66; also pp. 221–223, 1905.

reckoned as produce over the whole area, half in crop and half fallow, the whole acre grows much less both of grain and straw than where the crop is grown year after year on the same land.

An analysis of the results from alternately fallowed plats, however, shows the real benefits of fallowing. Both the seasonal rainfall and the amount of leaching from the land were measured for a series of years, and when the years of light rainfall and consequently diminished leaching are grouped together and contrasted with the years of heavy rainfall and increased leaching, it is seen that the yields following the drier season were high as compared with the others. Thus, for the years when the rainfall for the four months, September to December, inclusive, averaged 8.88 inches and the percolation was only 4 inches, the yield after the fallow was 2,743 pounds, as against 1,810 pounds on the continuous wheat plat, a gain of 933 pounds, or 52 per cent. For the group of years when the rainfall averaged 13.66 inches during the same four months and the percolation was 8.92 inches, the wheat after fallow yielded 1,757 pounds, against 1,627 on the continuous wheat plat, a gain of 130 pounds, or only 8 per cent. In other words, as a result of the decreased percolation more of the nitrates were left in the soil.

It seems probable from these results that with conditions such as exist on the dry lands of the Great Basin, where there is practically no loss by percolation, the products of nitrification during a fallow year would be quite sufficient to overcome any tendency toward the exhaustion of these soils.

THE FIXATION OF NITROGEN.

The bacterial action by which the complex proteids of the organic matter in the soil are converted into nitrates or other forms of nitrogen is but one of the several sources of the nitrate supply of soils. It is well known that bacteria living in the roots of some leguminous plants are able to combine atmospheric nitrogen into available forms, and it has been discovered more recently that practically all cultivated soils contain bacteria which are able to combine atmospheric nitrogen and make it available to plants, drawing their energy meanwhile from the carbohydrate material of the soil humus.[a]

There are many indications that the sustained productiveness of the dry-farmed soils of the Great Basin is due, in part at least, to the activities of this latter group of nitrogen-fixing bacteria. The same conditions that favor the action of the nitrifying or humus-reducing organisms also favor the action of the nitrogen-fixing bacteria, viz, a supply of carbohydrate material as furnished by disin-

[a] Hall, A. D. Science, N. S., 22: 453, 1905.

tegrating wheat straw, a good supply of soil moisture, high soil temperatures, and the presence of alkaline bases to combine with the nitric acid produced.

ORGANIC MATTER LOST BY OXIDATION.

In view of the importance of organic matter in maintaining the fertility of these dry-farmed soils there is a strong incentive to avoid excessive losses by direct oxidation.

In maintaining the clean summer fallow previously described, it is necessary to keep the upper 3 inches of the soil thoroughly stirred to form the surface mulch. This portion of the soil, being very dry and well aerated, is kept in a condition which is most favorable to "burning out" the organic matter which it contains.[a] The loss of organic matter in this way can not very well be avoided, for an effective surface mulch is necessary to prevent the loss of moisture from the lower soil. It is possible, however, to very greatly reduce the loss due to oxidation by deep plowing, which increases the depth of the surface soil in which the nitrification and nitrogen fixing can take place. These processes go on very slowly, if at all, in the soil below the furrow slice, so that deep plowing is very necessary to the best results in dry farming, not only as a factor in securing and conserving soil moisture but also in promoting the activities of the various organisms that work in the loosened soil and help to make it productive.

DRY FARMING SUPPLEMENTARY TO IRRIGATION.

With a few exceptions, the irrigated sections of the Great Basin are surrounded by arable lands which are either too high to be economically irrigated or too extensive to be irrigated with the available water supply. In the great majority of cases these lands receive rainfall enough for the production of some special crops even when it is insufficient to support farm homes or even for the growth of wheat and alfalfa with the best of tillage.

It is very doubtful whether a settler would be safe in attempting to make a home and start a farm on even the more promising of these dry lands. At the present time almost all the farming on the dry lands is done in connection with some irrigation farming. In many cases the farmer has little more than his garden and orchard under ditch, but it is at least enough to insure him fruits and vegetables for his table, and, if need be, a little forage for his stock in the event of a severe and protracted drought.

This plan of utilizing the unirrigable dry lands is much safer for the individual and is also much better for the community. Farming

[a] Storer, F. H. Agriculture, 2: 28–29, 1902.

with irrigation usually costs more per acre than dry farming, so that wherever it is possible to grow the cheaper staple crops without irrigation it pays to make the attempt. The products of the irrigated land, such as vegetables, fruits, and the succulent forage crops, then find a larger local market, because they can not be produced without irrigation, while live stock and some grain crops can often be produced much more cheaply on the dry lands. Thus the two portions of a community can supplement each other to the profit of both.

One of the most important effects of the development of dry farming adjacent to an irrigation settlement is the much-needed lesson it teaches of the value of tillage. Overirrigation with little or no tillage is the most common and serious failing of the western farmer. It is only where irrigation water is costly or can not be had at any price and when crops actually begin to fail that cultivation is seriously resorted to. As a result, it is only in those sections where irrigation is very new or where water is very scarce that the serious effects of overirrigation are not felt. Once the habit is formed, it is much easier to irrigate than to cultivate when a crop shows signs of distress. The ground is therefore filled with water, low places are swamped or made too alkaline for crops, and the fertility of the land is seriously impaired.

With the development of dry farming, however, the beneficial effects of tillage in conserving moisture and in increasing soil fertility give a constant and striking object lesson. When it becomes apparent that many of the same crops can be grown with adequate cultivation and without irrigation as successfully as they can be grown with irrigation alone, a farmer hesitates before undertaking to share the burden of expensive extensions to existing irrigation works. When the extension of a cultivated area is demanded, it becomes at once a practical question whether increased cultivation or increased construction shall be the basis of such extension. Wherever cultivation is resorted to in connection with irrigation the benefits are at once apparent, but without some continued object lesson or some real need, such as scarcity of irrigation water, it is seldom seriously undertaken.

MAKING A HOME ON THE DRY LANDS.

In any situation where dry farming is possible in connection with even a small amount of irrigation, there is much less risk involved than where there are no such opportunities. In fact, in any place where the rainfall is so light as to require extraordinary tillage methods in the production of ordinary crops there is considerable risk in establishing a home without the possibility of using irrigation for at least the farm garden. In nearly every semiarid region the varia-

tion in rainfall from year to year is very great, so that one must expect to experience occasional or even frequent dry years, when even with the best of care the ordinary garden crops would fail, and there might even be a shortage of forage for the stock.

It is therefore highly important in selecting a farm on the dry lands to secure provision for some irrigation, at least for the garden. The larger part of the dry lands of the western United States have underground water within reach. Some of them, indeed, overlie artesian basins, so that deep wells supply an abundance of water. In other cases water can be had by lifting, and with windmills or small engines it is considered quite feasible to lift water 200 feet or more for domestic uses and for garden irrigation.

A garden of some kind is almost a necessity for a farm home on the dry lands, as elsewhere, and the means and methods of providing it should be among the first considerations of a new settler.

It is sometimes possible to maintain a garden by taking advantage of the surface run-off after torrential rains, which may be collected by intercepting ditches and run into broad, shallow trenches in the garden until it settles into the ground. A view of a garden in which this method is used is shown in Plate IV, figure 2.

Where ground water lies very deep the expense of reaching it is often too great to be borne by a farmer individually, especially by a new settler, and it is then necessary to attempt a solution of the problem on a community basis. There are vast areas of land in the western United States with enough rainfall for dry farming, yet without any easily available supply of ground water even for domestic use. In some such regions it is often possible to collect rain water from buildings and store enough in cisterns for culinary purposes, but this is sometimes out of the question for a new settler in a treeless country, where building material is scarce and high priced and where he must be content to live for the first few years in a tent house or a small shack. In such situations the water problem must be solved by a community action.

In some instances the extension of dry farming around irrigated centers is limited only by the distance which farmers can afford to haul water to supply the horses or engines required for the farm work. In other cases large tracts of land that are well suited to dry farming are remaining undeveloped because of the absence of springs and the uncertainty as to the presence of an underground supply of water within reach and, if found, as to the proper location of wells.

One of the most urgent needs for the further development of dry farming in the Great Basin is a hydrographic survey for the purpose of determining the location and extent of the underground water resources. Without the information that such a survey might fur-

nish, settlers must either remain in immediate contact with an existing water supply or waste much money that they can ill afford to lose in blind attempts to locate water for themselves.

SUMMARY.

Dry farming in the Great Basin is limited at present almost entirely to the State of Utah, where it has been carried on to some extent since 1875 and its practice has been increasing rapidly since 1900. The work was initiated by private experiments, but the State of Utah is now supporting six experiment farms for testing varieties and working out scientifically the best rotation and tillage methods.

The precipitation comes during the autumn, winter, and spring months, differing in this respect from the precipitation on the dry lands east of the Rocky Mountains, where it comes during the summer months. Farming is successfully carried on with an annual average rainfall of 15 inches or slightly less. The annual variation in rainfall is considerable and the year 1906 was unusually wet. Local topography has a marked effect on the amount of rainfall.

Clean summer fallowing and alternate-year cropping, together with thorough tillage, are the basis of successful dry farming in the Great Basin.

Wheat and alfalfa are the most important crops now grown on the dry lands of the Great Basin. Thin seeding is found essential to the best results with these crops.

Under the best methods of tillage the land appears to remain highly productive even where no other crop than wheat is grown.

Dry farming is now used only as a supplement to irrigation farming. There have been few attempts to make homes on the dry lands.

The independent extension of farming on the dry lands depends upon the development of underground water for domestic use.

PLATES.

DESCRIPTION OF PLATES.

PLATE I. Fig. 1.—A general view of the San Juan County Arid Farm, a 40-acre farm maintained by the State of Utah for experimental purposes, located at Verdure, near the town of Monticello. This is one of six farms maintained by the State for similar purposes. The vegetation in the foreground is chiefly black sage, while the trees are juniper. Fig. 2.—A field of wheat in shock on land adjacent to the San Juan County Arid Farm. This field was covered with black sage two years ago.

PLATE II. Fig. 1.—Field showing the type of summer fallow maintained in every other series on the San Juan County Arid Farm. This serves at once to kill out weeds, conserve moisture, and promote humification in the soil. Fig. 2.—The interior of an alfalfa plat on the San Juan County Arid Farm. This alfalfa had been cut once and the plants in the interior of the plat made no second growth, while those along the margin next to the well-cultivated roadway were ready for a second cutting at the time shown in this illustration.

PLATE III. Fig. 1.—A poor crop of wheat on the Sevier County Arid Farm, Utah. The failure of this crop was apparently due chiefly to a lack of proper tillage during the previous season. Fig. 2.—A crop of wheat grown without irrigation in the Cache Valley, Utah. This land has been producing a crop of wheat every other year for thirty-five years. (Photographed by Mr. Charles J. Brand, 1906.)

PLATE IV. Fig. 1.—Harvesting wheat grown without irrigation near Nephi, Utah. A header like that shown will harvest about 25 acres a day. (Photographed by Mr. Charles J. Brand, 1906.) Fig. 2.—A hillside garden in a semiarid region, showing one of the settling ditches used to catch and hold the water which runs off the hill above.

FIG. 1.—GENERAL VIEW OF THE SAN JUAN COUNTY ARID FARM, UTAH.

FIG. 2.—FIELD OF WHEAT IN SHOCK ON LAND ADJACENT TO THE SAN JUAN COUNTY ARID FARM.

FIG. 1.—FIELD SHOWING THE TYPE OF SUMMER FALLOW MAINTAINED IN EVERY OTHER SERIES ON THE SAN JUAN COUNTY ARID FARM.

FIG. 2.—THE INTERIOR OF AN ALFALFA PLAT ON THE SAN JUAN COUNTY ARID FARM.

FIG. 1.—A POOR CROP OF WHEAT ON THE SEVIER COUNTY ARID FARM, UTAH.

FIG. 2.—A CROP OF WHEAT GROWN WITHOUT IRRIGATION IN THE CACHE VALLEY, UTAH.

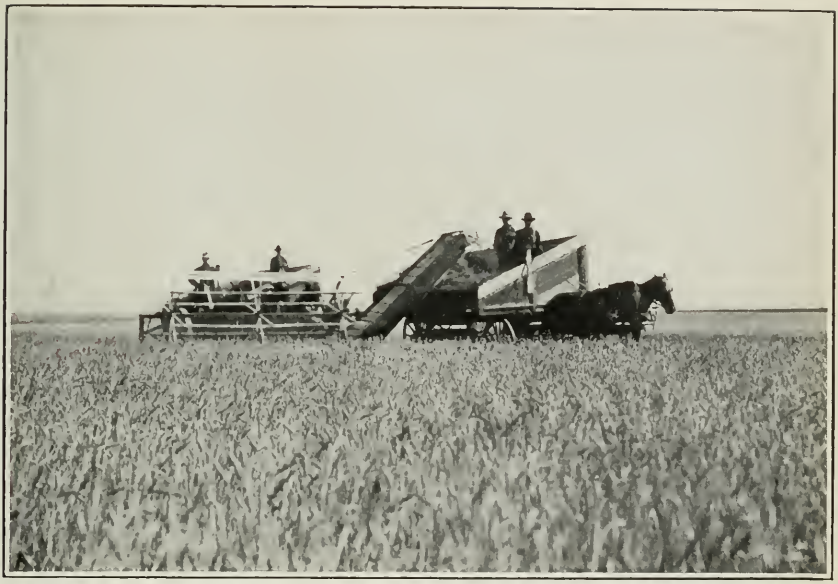

FIG. 1.—HARVESTING WHEAT GROWN WITHOUT IRRIGATION NEAR NEPHI, UTAH.

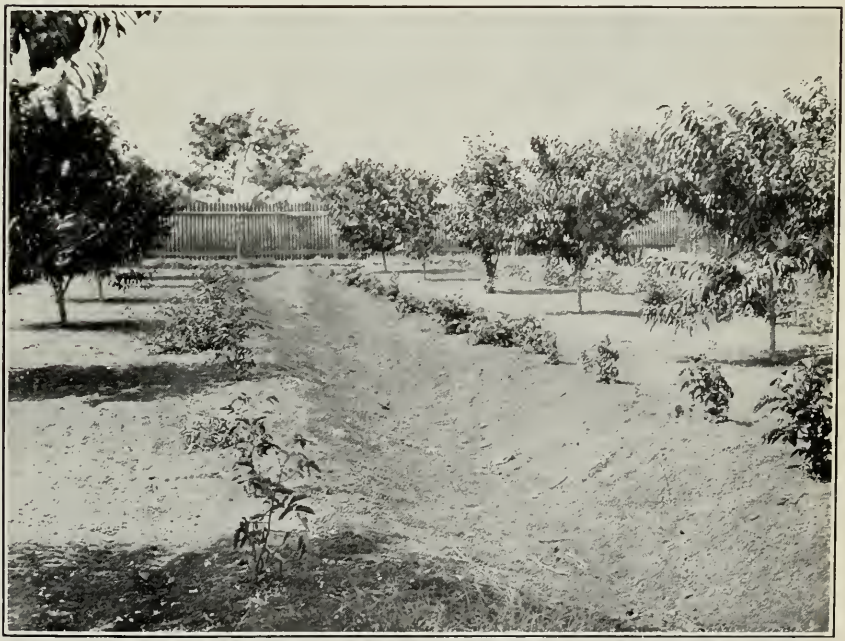

FIG. 2.—A HILLSIDE GARDEN IN A SEMIARID REGION, SHOWING ONE OF THE SETTLING DITCHES USED TO CATCH AND HOLD THE WATER WHICH RUNS OFF THE HILL ABOVE.

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U. S. DEPARTMENT OF AGRICULTURE.
BUREAU OF PLANT INDUSTRY—BULLETIN NO. 104.
B. T. GALLOWAY, *Chief of Bureau.*

THE USE OF FELDSPATHIC ROCKS AS FERTILIZERS.

BY

ALLERTON S. CUSHMAN,

ASSISTANT DIRECTOR, OFFICE OF PUBLIC ROADS, AND COLLABORATOR, BUREAU OF PLANT INDUSTRY.

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[Continued on page 3 of cover.]

U. S. DEPARTMENT OF AGRICULTURE.

BUREAU OF PLANT INDUSTRY—BULLETIN NO. 104.

B. T. GALLOWAY, *Chief of Bureau.*

THE USE OF FELDSPATHIC ROCKS AS FERTILIZERS.

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ALLERTON S. CUSHMAN.

ASSISTANT DIRECTOR, OFFICE OF PUBLIC ROADS, AND
COLLABORATOR, BUREAU OF PLANT INDUSTRY.

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LETTER OF TRANSMITTAL.

U. S. Department of Agriculture,
Bureau of Plant Industry,
Office of the Chief,
Washington, D. C., March 20, 1907.

Sir: I have the honor to transmit herewith a manuscript containing a review of all the work that has been done up to the present time in the investigation of the use of finely ground feldspathic rocks as fertilizers. There is a constantly growing demand for accurate information on this subject, and I therefore recommend that this manuscript be published as Bulletin No. 104 of the Bureau of Plant Industry.

Respectfully,

B. T. Galloway,
Chief of Bureau.

Hon. James Wilson,
Secretary of Agriculture.

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B. P. I.—275.

THE USE OF FELDSPATHIC ROCKS AS FERTILIZERS.

INTRODUCTION.

In view of the great demands that are being made upon the agricultural resources of the country, it is a matter of vital importance that consideration be given to the available supplies of elements which are necessary to sustain and maintain the quality and quantity of the crops. It is well known that there are three principal fertilizing materials: Nitrogen, phosphoric acid, and potash. The discovery of electrochemical and bacteriological processes for fixing the nitrogen of the air, thereby changing it into a form in which it can be used as a plant food, seems to remove all doubt as to the abundance of the supply of this important element for all time to come. An enormous geographical area of this continent is underlain with practically inexhaustible supplies of phosphatic rock, which, with the phosphates obtainable in waste bone, slaughterhouse tankage, fish scrap, and the basic slags from the iron industry, insure a limitless supply of phosphoric acid.

With regard to potash alone there has been reason to feel anxiety. Up to the present time no deposit or source of this necessary element in any of the forms in which it has been heretofore considered available as a plant food has been discovered or developed in this country. The mines of Stassfurt, Germany, furnish almost the entire supply of potash for fertilizer in the United States, exclusive of that which is used over and over by the processes of natural and green manuring. The potash salts, which up to this time have been exclusively used for fertilizing, consist of muriate, sulphate, nitrate, and carbonate, either in a crude or in a previously purified condition. Kainite is a trade name given to a crude product of the German mines, which contains about 13 per cent of actual potash, largely in the forms of sulphate and chlorid (muriate). The quantity and value of potash salt to be used as fertilizers imported in the fiscal years 1903, 1904, and 1905 are shown in the following table. The price of the potash unit has shown a tendency to increase each year.

TABLE I.—*Imports of potash salts for use as fertilizers.*[a]

Kind of fertilizer.	1903.		1904.		1905.	
	Weight.	Value.	Weight.	Value.	Weight.	Value.
	Pounds.	*Dollars.*	*Pounds.*	*Dollars.*	*Pounds.*	*Dollars.*
Crude carbonate	11,130,789	141,033	8,193,872	224,396	7,166,569	218,816
Crude muriate	172,838,780	2,630,457	161,503,735	2,428,480	202,366,601	3,241,152
Crude nitrate	11,946,685	320,082	16,727,175	433,626	14,512,306	386,098
Crude sulphate	45,156,964	782,082	47,592,131	833,954	54,577,670	958,305
Kainite	553,875,840	1,080,393	356,124,160	839,382	539,369,488	1,143,296
Total	794,949,058	4,954,047	590,141,073	4,759,838	817,992,634	5,947,667

[a] Compiled from data furnished by the Bureau of Statistics, U. S. Department of Agriculture.

All of the above salts of potash are readily soluble in water and therefore become quickly available as plant food when applied as fertilizers. On the other hand, the acids with which the potash is combined in these salts, especially in the cases of the sulphate and chlorid, are absorbed only in extremely minute quantities by growing plants. The natural consequence of this is that as the potash is taken away year after year the acid elements collect, in some cases to the great detriment of the soil.

Potash in some form is absolutely necessary to the successful growth of all crops, and is found in varying degrees in the ashes of wood and of vegetable growths of all kinds. This is illustrated in the following table, in which analyses of ashes of a number of vegetables are given. It must be remembered, however, that the amounts of this element found in the ashes of plants vary greatly under different conditions and that the sap of plants frequently absorbs much more of a given element than is actually necessary for its growth. The important point is that potash is an essential plant food of all crops, and particularly of those species which are starch builders.

TABLE II.—*Analyses of vegetable ash.*

Ash.	Phosphoric acid (P_2O_5).	Potash (K_2O).	Soda (Na_2O).	Ash.	Phosphoric acid (P_2O_5).	Potash (K_2O).	Soda (Na_2O).
	Per cent.	*Per cent.*	*Per cent.*		*Per cent.*	*Per cent.*	*Per cent.*
Pea	36	40	1	Cabbage	16	48	4
Bean	30	44	1	Turnip	13	39	5
Potato	19	59	2	Artichoke	16	65	2
Parsnip	18	36	5	Tobacco	15	49	11
Carrot	12	36	13				

We can trace the source of potash in all its forms and wherever found to the igneous rocks which constituted the original crust of the earth. From the averages obtained from the analyses of a large number of crystalline rocks of common occurrence found in this coun-

try, Clarke[a] has made the following calculations of the relative abundance of various rock-forming minerals:

	Per cent.
Apatite (phosphate of lime)	0.6
Titanium minerals (oxids and silicates)	1.5
Quartz (silica)	12.5
Feldspar (silicates of aluminum, potash, soda, and lime)	59.0
Biotite mica (silicates of aluminum, magnesium, potash, etc.)	3.8
Hornblende and pyroxene (complex silicates)	16.8
Miscellaneous	5.8
Total	100.0

It is seen from this that probably the majority of all the original rocks contain more than 50 per cent of feldspar. There are, however, a great many different varieties of feldspar. The feldspars belong to a type of minerals known as silicates, in which aluminum and other elements, such as potash, soda, and lime, are combined with silica. Pure orthoclase feldspar is a silicate of aluminum and potash, which theoretically should contain 16.8 per cent of potash (K_2O). As a matter of fact it is extremely difficult to find an example of pure orthoclase, and in most of the feldspars, which occur in large deposits, the potash is to a greater or less extent replaced by soda or lime, or both. For this reason it is impossible to tell without a chemical analysis how much potash any given feldspar will contain. The granite rocks consist of feldspar, quartz, and a little mica in varying proportions; many of the other well-known rocks, such as the slates, sandstones, gneisses, and traps, also frequently contain more or less feldspar. Some of these rocks carry little or no potash, although many of them will run as high as 5 per cent; very few of them run higher than this.

A cubic foot of granite weighs about 170 pounds; on a 5 per cent basis, 8.5 pounds of this is potash. A quarry 100 feet square and 100 feet in depth of such rock would therefore contain 8,500,000 pounds of potash (K_2O). It is at once apparent that nature offers a limitless supply of raw material which only awaits an economical process to make the potash available.

In many localities there occur large dikes or deposits of more or less pure feldspars, which usually run higher in potash than the true granite rocks. These large deposits, which occur in a great many of the States, have been developed in Maine, Connecticut, Pennsylvania, New York, and Maryland, where they have been mined extensively and the feldspar ground to fine powder, principally for use in potteries. As has been said, pure orthoclase feldspar should contain 16.8 per cent of potash (K_2O), but none of these deposits will run on the average much more than 8 to 10 per cent. For pottery use it is essential that the spar should melt in a kiln fire to a clear white glass,

[a] Bul. 228, U. S. Geol. Survey, p. 20.

and it must therefore be almost entirely free from mica or iron-bearing minerals. For this reason there are large quantities of materials at every feldspar quarry which, though unfit for pottery use, would be valuable if any method were known of making potash available.

The question whether fine-ground feldspar can be used as a potash fertilizer has been a matter of controversy for many years. There is a large and widely scattered literature on the subject, an examination of which shows that the matter has been debated with much vigor and sometimes with prejudice and intolerance on both sides. It is easy to find the published records of a number of experiments, made by trained and thoroughly competent agriculturists, which tend to show that ground feldspar is an efficient potash fertilizer. On the other hand, a number of experiments seem to indicate that the potash is only slightly available, while others would appear to show that the ground rock is entirely useless. On account of the large interests involved in the settlement of this question it is not difficult to see why vigorous differences of opinion, and even unjust prejudice, should have arisen. When, however, trained investigators reach opposite conclusions, based upon experimental evidence, we are forced to the opinion that while ground feldspar may be a useful fertilizer under certain conditions it is not so under others.

It is the object of this bulletin to present and discuss as fully as possible all the evidence that can be obtained on both sides of this important question. The great demand for information on the subject which has arisen and the numerous misstatements that have been printed make it desirable to present the evidence obtained up to date, even though many more years will be necessary for the conclusion of careful systematic investigation under crop and field conditions.

The availability of potash contained in feldspathic rock must depend upon several important considerations, which can best be expressed by a discussion of the following questions:

(1) Is the potash locked up in feldspar and the feldspathic rocks, such as granite, gneiss, rhyolite, syenite, etc., to any extent available as a fertilizer when these rocks are crushed or ground to fine powder?

(2) If the first question can be answered in the affirmative, what influence does fineness of grinding have on the question, and to what degree of fineness is it necessary to grind in order to make a sufficient amount of potash available in the first season after application?

(3) What would be the cost of using ground rock in place of the soluble compounds which up to the present time have been exclusively used, and would there be economy in so doing?

(4) Could any subsequent damage result from the use of ground rock; and if so, how would such damage compare with that which follows the continued use of soluble compounds, such as chlorids, sulphates, and carbonates?

(5) If it should be determined that the potash in ground feldspathic rock is only partially available as a fertilizer, is there any method or process by which the ground rock could be treated so as to increase this availability?

THE AVAILABILITY OF POTASH IN GROUND ROCK.

The attention of the writer was first turned to the availability of potash in ground rock by a study of the decomposition which takes place when various rocks are used to form the surface of macadam roads. The binding power of rock dust depends upon the decomposition of the particles under the action of water and other substances. It has always been believed heretofore that only the potash that could be leached or dissolved out of a finely ground material with water was available for plant growth. As a matter of fact even the most finely ground feldspar which it is possible to obtain yields extremely minute quantities of potash to actual solution in water. Feldspar which contained about 10 per cent of potash and was ground to a very fine powder yielded only 0.025 per cent to solution in water, and only 0.036 per cent to the action of a dilute acid. A large number of similar observations has led to the confident belief, almost universally held for many years, that although rocks which were disintegrated by natural processes served as the original source of potash, the action was so slow that it would be useless to grind rocks and attempt to use them as fertilizers. In the writer's investigations, however, evidence has been obtained which seems to show that decomposition of fine-ground feldspar goes much farther than was indicated by the simple solution tests with water and dilute acids. By the use of laboratory methods it has been shown that almost complete decomposition can be made to take place in comparatively short periods of time under the action of water alone. In order to accomplish this result it has been necessary to use a method by which the potash is continually removed as fast as it is set free from its combinations in the rock. Now, as the roots of plants are continually performing this function, it is possible that in nature the decomposition of the feldspathic particles in the soil must be continually going on as long as the product is being used, and slowing down to the stopping point when no removal is effected by plant growth. For further information on the scientific discussion of the decomposition of the feldspars the original papers should be consulted.[a]

The fact, frequently cited and familiar to almost every person, that rocky hillsides with little or no soil can support growths of timber, would appear to demonstrate that rock potash is available. When it is remembered that wood ashes contain anywhere from 5 to 12 per cent of potash, it will be seen that a large tree represents, as it stands, a considerable quantity of this substance. However, trees

[a] Bul. 92, Bureau of Chemistry, U. S. Dept. of Agriculture; Cir. 38 and Bul. 28, Office of Public Roads.

take a long time to grow, and this present inquiry is mainly confined to availability in a single year from finely ground material.

In order to put the availability of the potash in very finely ground feldspathic rocks to actual test the writer undertook some preliminary experiments in the greenhouse. Tobacco was selected for the experiments because, besides being extremely dependent upon an abundant potash supply, this plant is particularly well adapted to observation and control. Artificial soils were made up of clear, close-grained white sand and finely ground feldspar, running about 8 per cent potash, such as is ordinarily prepared for use in the potteries, and which will pass through a standard sieve of about 200 meshes to the linear inch, having apertures approximately 0.0024 inch square. Tobacco seedlings were set out in this mixture and carefully fed from day to day with dilute solutions of ammonium nitrate and ammonium phosphate in order to supply the necessary amount of nitrogen and phosphoric acid. In addition to this, a small amount of salts, containing lime, magnesia, and iron, was also added to the food solutions. Every care was taken, however, to see that no potash, except that which might be supplied by the feldspar, obtained access to the plants.

For the sake of comparison, plants were also grown at the same time in a rich composted loam soil, which contained an abundance of all plant foods, including potash. Although the artificial sand-feldspar soil was hard and apparently unsuited to the growth of plants, the tobacco nevertheless throve well in it, and showed at no time the slightest indication of potash starvation. When the experiments were finally abandoned, the tobacco plants growing in the sand feldspar had attained a height of about 3 feet, and showed every indication of being as perfectly nourished as those growing in the rich soil.

In addition to the above experiments, seedlings were also set out in a poor, unfertilized soil, with and without the addition and admixture of a certain proportion of the ground feldspar. Here also the availablity of the feldspar potash was clearly indicated.

These experiments, which were made in the summer of 1905, were not considered conclusive, but were sufficiently encouraging to justify further and more systematic investigation. Before proceeding it was of course necessary to look up the literature of the subject, in order to see to what extent ground feldspar had been experimented with by other investigators. A bulletin of the United States Department of Agriculture, which appeared a short time after the conclusion of the preliminary experiments described above, contains a partial reference list of previous publications along this line.[a]

[a] Bul. 30, Bureau of Soils, U. S. Dept. Agriculture, p. 26.

On account of the great interest which has been aroused in this important subject and in order to present all the facts in the most accurate manner, the work of previous experimenters will be given in as much detail as space will permit. It is the intention to bring together all the information and evidence that the literature of the subject affords, whether it appears to be favorable to the use of ground feldspar, or the reverse.

In 1849 Salm-Horstmar[a] published in a German scientific journal a method of preparing an artificial soil which, while being open, porous, and of a soft texture, should be absolutely free from all plant foods except those which were purposely added to it. The purest crystallized sugar was burned to a light form of charcoal and found to be absolutely free from any impurity capable of furnishing nourishment to plants. All sorts of different substances were then added to this material in other pots, and plants grown in them. In this way the experiments were kept under accurate observation and much information was obtained of the actual foods, and their forms, which are necessary to carry on the nourishment of plants. A short time after this investigation, in 1850, a chemist named Magnus[b] repeated these experiments, and also made others. In addition to the pots filled with sugar-charcoal, some of the pots were filled with coarsely pulverized feldspar. It was found that the plants growing in the feldspar made a good growth, even if no other food containing potash was added. The finer the feldspar was ground the better was the development of the plants. Magnus summed up the results of his investigations as follows:

(1) In the absence of all mineral plant foods, barley attained a height of about 5 inches only before dying.

(2) The addition of very small amounts of mineral plant foods enabled the plants to reach complete development.

(3) If too much plant food was present, the plants were stunted or refused to grow at all.

(4) In pure feldspar barley made complete development and matured grain.

(5) The development of growth varied with the coarseness or fineness of the feldspar.

In 1861 Reichardt,[c] a distinguished agricultural chemist, advanced the opinion that granite, porphyry, and other rocks rich in orthoclase feldspar quickly give up their potash to plants when the particles are very fine.

About 1884 Hensel,[d] a German writer and chemist, advocated the use of ground rock or so-called "stone meal," not only in order to supply the requisite potash, but also the phosphates and other mineral

[a] Jour. für Prakt. Chem., 1849, 46, 193.

[b] Ibid., 1850, 50, 65.

[c] Ackerbau Chemie (1861).

[d] A. J. Tafel, Bread from Stones, 1894.

plant foods, such as lime, magnesia, iron, and manganese. This author published a philosophical work entitled "Das Leben," which treated in part of the use of rock fertilizers. Hensel thought that the use of excreta, offal, and other decaying and waste material as manure was harmful, if not to plants, at least to animals and men who subsisted upon them. Like many enthusiasts, Hensel appears to have been completely carried away by his ideas, which were not always justified by known facts. Hensel obtained, nevertheless, a considerable following[a] and factories were established to prepare stone meal. The subject evoked much discussion in Germany for many years. Whether rightly or wrongly, Hensel's ideas provoked the antagonism of nearly all the leading exponents of agricultural science in Germany. A great many experiments were undertaken and in many cases the stone meal as prepared by the factories was shown to be very low in plant foods and nearly worthless as a fertilizer.

Among the prominent agricultural chemists who waged war on Hensel's stone meal were Wagner,[b] Böttcher,[c] Steglich,[d] Hentschel,[e] Pfeiffer and Hansen,[f] and Morgen.[g]

In some respects Hensel's arguments were not without weight, and he was keenly aware of the necessity for very fine grinding before the mineral constituents of rocks could be considered as practically available. The following quotation[h] from a translation of Hensel's work stands for itself:

> The practical point to settle is how far fertilizing with stone meal pays, what yields it will afford; thus, whether it will be profitable for the farmer to use it. * * * It must here be premised that the fineness of the stamping or grinding and the most complete intermixture of the constituent parts are of the greatest importance for securing the greatest benefit of stone-meal fertilizing. A manufactured article of this kind has recently been submitted to me which showed in a sieve of modern fineness three-fourths of the weight in coarse residuum. But as the solubility of the stone meal, and thus its efficiency, increases in proportion to its fineness, the greatest possible circumspection is required in grinding it. The finer the stone dust the more energetically can the dissolving moisture of the soil and the oxygen and nitrogen of the air act upon it. A grain of stone dust of moderate fineness may be reduced in a mortar of agate perhaps into twenty little particles, and then every little particle may be rendered accessible to the water and the air, and can, therefore, be used as plant food. Thence it follows that one single load of the very finest stone meal will do as much as twenty loads of a coarser product, so that by reducing to the finest dust, the

[a] Pomol. Monatshefte, No. 1 (1892); also Wegweiser zur Gesundheit, September 15, 1891.

[b] Zeit. Landw. Vereine Hessen, 1894, 64, 14.

[c] Centbl. Agr. Chem., 1895, 24, 363.

[d] Ibid., 1895, 24, 423.

[e] Ibid., 1896, 25, 136.

[f] Ibid., 1896, 25, 802.

[g] Ibid., 1898, 27, 743.

[h] A. J. Tafel, Bread from Stones, 1894, p. 53.

cost for freight and carriage and the use of horse and cart would amount to only one-twentieth. Therefore we can afford to pay unhesitatingly a higher price for the finest stone meal that has been passed through a sieve than for an article that may be not so much a fine powder but rather a kind of coarse sand.

Inasmuch as this bulletin is interested mainly with the inquiry concerning the use of fine-ground feldspar or feldspathic rocks known to be rich in potash, no greater space need be given the German stone meal discussion.

Some experiments were carried out in 1887 on the use of ground feldspar as a fertilizer by Aitken, a Scotch agriculturist, and chemist to the Highland and Agricultural Society of Scotland. Aitken does not say that he was aware of the work of Magnus or the deductions of Hensel. The record of these experiments is given in the author's own words:[a]

We are familiar with the fact that feldspar, under the slow but constant action of those forces included under the name of weathering, becomes disintegrated and decomposed, and that the potash it contains is dissolved away from it by rain, so that streams emanating from districts where feldspathic rocks abound are found to contain potash salts, and the level straths laid down by the prolonged action of these streams yield fertile soils that are rich in potash. These soils are the product of natural agencies that have been going on for centuries, and the store of soluble potash salts they contain has been increased to an untold extent by the slow solvent action of the roots of plants that have grown on them, so that the conversion of feldspathic rock into soil so rich in potash as to afford an abundant supply of that constituent for the raising of agricultural crops is the product of the work of centuries. At first sight, it might seem a foolish thing to expect that by merely grinding feldspathic rock, and strewing the powder upon soils deficient in potash, the long natural process referred to should be so accelerated as to cause the feldspar to act as a source of potash for the immediate use of the growing of crops whose vigorous growth demands a relatively large amount of that substance. Nevertheless, the striking results of an experiment made at the society's experiment station at Pumpherston showed that such an expectation was not altogether unreasonable. Ground phosphates had been used as a phosphatic manure with varying success for some years, and as it seemed that the varying nature of the results obtained might be due to the varying degrees of fineness to which phosphates were ground, I made a small preliminary experiment, in which the same phosphate was applied in different degrees of fineness, and I found that the more finely ground the phosphate the more effective was it as a manure. A similar experiment on a larger scale is described in the present volume of the Transactions, page 245, where it is seen that the efficiency of ground phosphates is in direct proportion to their fineness. It therefore seemed reasonable to suppose that feldspar, although it is a very insoluble substance, might, if it were ground to an exceedingly fine powder in certain circumstances, be found to yield to the action of the solvents in the soil and in the roots of plants so rapidly as to be available as a source of potash to some crops, even during the short period of a single season.

Accordingly I obtained, through Mr. Bödker, the Swedish and Norwegian consul here, at whose instigation the experiment was undertaken, a supply of very

[a] Trans. Highland and Agr. Soc. Scotland, 1887, ser. 4, 19, 253.

pure feldspathic rock, rich in potash, of which enormous quantities are to be had in Norway. It was ground as finely as possible by Messrs. J. & J. Cunningham, of Leith, and thereafter sifted through a sieve of 120 wires to the linear inch, and was found to contain about 12 per cent of potash. The whole quantity of sifted feldspar was very small, less than a half hundredweight, and as it was received late in the season, the experiment was made simply to afford information which might indicate whether it was desirable to try the experiment on a larger scale the following season. There were two small experiments made—one by Mr. R. Shirra Gibb, at Boon, on a crop of peas, and one at Pumpherston on turnips. The experiments were on plots of one-fortieth acre, and the following were the manures employed and the results obtained:

	Kind and quantity of fertilizers.	Peas.		Turnips.
		Dried in bulk.	Grain.	Bulbs.
		Pounds.	*Pounds.*	*Pounds.*
1.	Sulphate of potash, 3 pounds Sulphate of lime, 3 pounds Superphosphate, 6 pounds	114	3.8	482
2.	Ground feldspar, 12 pounds Sulphate of lime, 3 pounds Superphosphate, 6 pounds	102	3.5	496
3.	Sulphate of lime, 3 pounds Superphosphate, 6 pounds	96	.....	476

Although the whole experiment is on a small scale, and the crops are below the average, there is nevertheless a clear indication that the feldspar has acted as a potash manure. In both cases where no potash was applied the crop is the smallest. At Boon the plot with no potash was unable to mature its seed, so that it could not be thrashed, while on the other two plots the amount of seed was not very different, and quite in proportion to the total crop, viz, about one-fortieth. The smallness of the crop does not detract from the value of the experiment as a means of indicating whether or not feldspar acts as a potash manure. Had the crop been sown at the proper time it would have been much larger. In the case of the turnip crop the ground feldspar has done better than the sulphate of potash. That may be accidental, but it may be that the insoluble form in which potash is contained in feldspar is more favorable for turnip growing than the soluble sulphate. Soluble potash manures, when applied to the turnip crop, sometimes diminish rather than increase the crop, and this is especially the case where the crop is dunged in the drills; but no dung has been put on the Pumpherston station these twelve years, and the results obtained all over the field show that potash is now required for turnip growing on that land.

Upon the whole, the result of this experiment may be taken as showing that potash feldspar when ground to an exceedingly fine powder is capable of acting as a potash manure even in a single season.

In 1889 the Maine State experiment station,[a] under Balentine, independently of any previous experimenters, investigated the use of ground feldspar as a source of potash on oats. The results are given verbatim from the records of the station:

In connection with the experiments with finely ground phosphatic rock as a source of phosphoric acid for plants, pot experiments have been undertaken to determine to what extent plants can avail themselves of the potash of potash

[a] Ann. Rept. Maine State Col. Exp. Sta., 1889, p. 143.

feldspars. The pots used for the experiments were like those used in the phosphate experiments. They were also filled in the same manner, having first a layer of gravel at the bottom and above this 65 pounds of quartz sand, with the last 35 pounds of which were mixed the experimental fertilizers.

Three pots, 1, 5, and 9, were supplied each with 10 grams of feldspar carrying 11.61 per cent of potash, 10 grams of nitrate of soda, and 10 grams of acid South Carolina rock. Three other pots, 13, 17, and 20, were fertilized with 20 grams of feldspar and the same amount of nitrate of soda and acid phosphate as was supplied to 1, 5, and 9. In these pots were planted oats. When the oats were 2 or 3 inches high they were thinned out to 18 plants per pot. The pots were watered in the same manner as were those in which the experiment with phosphates was conducted.

In the table below are shown the results of substituting muriate of potash for feldspar as a source of potash:

Kind and quantity of fertilizers.	Number of pot.	Yield of grain, in grams.	Yield of straw, in grams.
10 grams feldspar	1	18.37	47
10 grams nitrate of soda	5	14.37	43
10 grams acid South Carolina rock	9	19.43	47
20 grams feldspar	13	17.28	47
10 grams nitrate of soda	17	16.78	47
10 grams acid South Carolina rock	21	16.83	52
3 grams muriate of potash	16	22.88	67
10 grams nitrate of soda	20	18.85	72
10 grams acid South Carolina rock	24	24.37	65

The pots receiving 10 grams of feldspar produced, on the average, about 79 per cent of the average of the grain produced by those pots receiving 3 grams of muriate of potash having 50 per cent of actual potash. The amount of grain was not increased by increasing the feldspar to 20 grams, though there was a slight gain in straw.

The conclusion to be drawn from the experiment is that the oats were able to draw from the feldspar potash enough for a large crop of grain. If this conclusion is verified by future work, some of our feldspars may prove a cheap source of potash to the farmers of the State.

Examination of the figures given in the above table shows that the potash from the feldspar undoubtedly became available, but was not as efficient as that from the more soluble muriate.

In 1889, the same year that the results of these experiments were made public, Nilson [a] in Sweden published an investigation in which fine-ground feldspar prepared for the potteries was tested in comparison with potassium sulphate. Oats were used, and the experiments were carried out on the Swedish moor soils, which, in a dry condition, already contained 0.5 per cent of potash, although only 0.03 per cent of this was soluble in dilute acid. There were 300 kilograms (660 pounds) of slag phosphate, 50 kilograms (110 pounds) of nitrogen in the form of Chile saltpeter, and 80 kilograms (176 pounds) of potash as sulphate or 200 to 300 kilograms

[a] Landtbr. Akad. Handlingar och Tidskr., 1889. See also Centbl. Agr. Chem., 1889, 18, 608.

(440 to 660 pounds) as ground feldspar added to the hectare (2.47 acres). The results of weighings of crop yield, made on the basis of 100 plants from each trial, are given in the following table:

Weight of crop of oats from seven plats of 100 plants each, grown with various fertilizers.

Kind of fertilizer.	No.	Grain.	Straw.	Chaff.	Total.	Equivalent yield of grain per hectare.
		Grams.	*Grams.*	*Grams.*	*Grams.*	*Kilograms.*
Unfertilized	1	5.3	11.0	1.0	17.3	216
Phosphate and potassium sulphate	2	157.3	220.5	16.3	394.1	6,400
Phosphate and 300 feldspar potash	3	133.8	178.7	15.5	328.0	5,450
Phosphate and Chile saltpeter	4	175.5	242.8	21.2	439.5	7,150
Phosphate, Chile saltpeter, and potassium sulphate	5	232.5	346.2	24.8	603.5	9,470
Phosphate, Chile saltpeter, and 200 feldspar potash	6	171.5	245.2	21.3	438.0	7,000
Phosphate, Chile saltpeter, and 300 feldspar potash	7	177.7	262.5	23.5	463.7	7,240

Nilson's results are most unfavorable to ground feldspar, as an inspection of the figures shows, but as a very good yield was obtained by the use of Chile saltpeter and phosphate without any additional potash, the experiments are not very conclusive. Chile saltpeter is a crude nitrate of soda which sometimes contains potash salts. It is possible that in all these experiments there was a tendency to overfeeding rather than to underfeeding.

In 1890 Sestini[a] published the results of a very interesting investigation of the decomposing action of plant roots on feldspar. A coarse feldspathic granite sand from the island of Elba was first carefully washed to remove all adherent earth or plant food, and then mixed with certain amounts of carbonate, phosphate, and sulphate of lime. The nitrogen was supplied in the form of ammonium nitrate. Various plants and grasses were grown in this mixture under very careful test conditions. The crops matured well, and at the end of about a year it was shown that a very considerable decomposition of the feldspar had taken place. Sestini concluded that the decomposition of the feldspar went on much more rapidly under the influence of plant growth than had previously been supposed.

In 1901 Headden,[b] working at the Colorado experiment station, also independently, carried on some interesting experiments on the availability of potash contained in ground feldspar. To quote this author's own words:

We endeavored to determine whether the feldspar could furnish potash to plants. For this purpose the perfectly fresh mineral was used, pulverized as already described in imitation of the soil, i. e., the particles varied from

[a] Landw. Vers. Stat., 1900, 54, 147.

[b] Bul. 65, Colorado Exp. Sta., p. 30.

1 millimeter in diameter to an impalpable powder. This was mixed with pure quartz sand. Bone ash was used to supply lime and phosphoric acid. The sample used contained no potash. Nitrate of lime furnished the nitrogen. Chlorine was furnished by a minute quantity of calcic chloride. Distilled water was used throughout the experiment.

The plants grew healthily in this mixture until the floors of the building were oiled and the room in which the plants were growing was shut up and became too warm; these two things together gave them a decided setback, and later a thrips, *Thrips striata* according to Professor Gillette, attacked the plants and did them much damage. Some of the plants, however, seeded. They were harvested, though in bad condition and very uneven in the degree of their development. The root system was well developed, the sand being filled with the roots. The weight of the tops as harvested was 198.5 grams; that of the roots as washed out was 40 grams. The tops and roots were incinerated together and yielded 5.795 per cent of soluble and 9.803 per cent of insoluble ash, a total of 15.598 per cent.

Examination of the feldspars used showed the presence of 11.993 per cent of potash and 2.988 per cent of soda. Phosphoric and sulphuric acids were present in very small quantities; the former equaled 0.041 per cent and the latter 0.003 per cent of the feldspar.

The nitrogen in the oat hay, roots included, was 3.2543 per cent.

The ash gave the following analysis:

	Per cent.		Per cent.
Carbon	0.17	Calcic oxide	21.70
Sand	8.13	Magnesic oxide	3.90
Silicic acid	15.73	Ferric oxide	.96
Sulphuric acid	4.41	Aluminic oxide	.31
Phosphoric acid	3.98	Manganic oxide	.16
Carbonic acid	15.35	Ignition	2.61
Chlorine	2.73		
Potassic oxide	15.95		100.71
Sodic oxide	4.62		

This ash is very anomalous in its composition as well as in the quantity present in the plants. The plants were not evenly matured at the time of gathering and were in bad condition. The question we endeavored to investigate, however, is perfectly answered by the results, i. e., the oat plant can use the finely divided feldspar as a source from which to obtain potash, for in this experiment, made under very adverse conditions, we found that the oat plants took from the feldspar 1.4417 grams of potash. The potash added in the seed has been deducted. The silicic acid appropriated by the plant indicates the decomposition of the silicate.

In 1905 Prianischnikow,[a] a Russian investigator, published the results of a series of pot tests using feldspar and mica as sources of potash. The feldspar used was ground so that it was less than 0.25 mm. in diameter, corresponding to an 80-mesh sieve. The material was mixed with sand and the other foods added in the form of phosphates and nitrates of lime and soda. The cultures used were tobacco, buckwheat, flax, peas, sunflowers, and barley. The tabulated results are too voluminous for insertion here, but they appear to show that

[a] Landw. Vers. Stat., 1905, 63, 151.

the feldspar, even in large amounts, had little or no effect on the growth of the plants. The investigator concluded that mica is, if anything, a better source of potash than feldspar, but that neither of these minerals supplies a sufficient quantity to make them worth the slightest consideration so far as plant growth is concerned. The only criticism of these experiments that might be offered is that 80-mesh feldspar powder is far too coarse to be used in pot experiments. This point will be taken up more fully later on.

The most important researches which have ever been published tending to show that under certain conditions finely ground feldspar is worthless as a fertilizer are those of von Feilitzen.[a] This experimenter, like Nilson, worked on Swedish moor soils. He concluded that ground feldspar is almost worthless as a fertilizer. The results and conclusions are best shown by abstracting from a translation from von Feilitzen's publications:[b]

Potash, as is well known, is one of the necessary constituents of plant food; consequently, if it is absent in the soil or only there in insufficient quantities, a normal development of the higher orders of plants is not possible. According to the researches of plant physiologists, it is particularly instrumental in the formation and transport of the carbohydrates (sugar, starch, etc.), for which reason potash plays such a prominent part in the manuring of potatoes, turnips, and other root crops, but it is also required for cereals and all the other cultivated plants. Of late, comprehensive experiments have been carried out by Prof. Dr. H. Wilfarth at the experimental station at Bernburg, with the view to ascertain in what way the want of one or several of the necessary constituents of plant food influenced the development and appearance of plants. On this occasion he found that the want of potash caused a defective growth of some of the vegetative parts, the leaves of potatoes, tobacco, buckwheat, and beetroots assuming a speckled appearance.[c] Certain clearly defined portions, especially at the borders of the leaves, grew yellowish-white and decayed, while the other parts retained their original appearance. These marks are often very much like those caused by fungi and insects, but if examined more closely it becomes evident that they can not be due to such causes.

In 1903 we made quite similar observations, when experimenting with clover and timothy grass, and, as it should be of interest, I shall describe in short the observations made by us. In 1902 a series of experiments were prepared in plots of soil of 1 square meter each (about 1 yard square), charged with rather well-decayed reed grass turf, poor in potash, in order to investigate whether the potash in a mineral fertilizer, prepared in Sweden, was of any manurial value. As, by analysis, this fertilizer turned out to be finely ground feldspar, we were prepared for an unfavorable result at the very outset.

The fineness of the ground feldspar is not given, but an analysis showed that it contained 8.15 per cent of potash. The experimental series was made up of two plats, each fertilized as shown in the following table, and in May, 1902, they were sown with a clover-grass

[a] Exp. Sta. Record, U. S. Dept. Agriculture, 1904, 16, 30.

[b] How Deficiency in Potash Affects Clover and Timothy.

[c] Jour. für Landw., 1903, No. 11.

mixture containing red clover, bastard clover (alsike), white clover, and timothy grass. Even in the first year the grass developed vigorously and produced vegetable matter, as shown in the table. An average of 1 square meter of each of the two parallel plats was taken. Fifty-four pounds of phosphoric acid were used on each plat.

Plat number.	Kind and quantity of fertilizer per acre.	Green vegetable matter produced—average of 2 plats.	Increase due to potash—average of 2 plats.
		Pounds.	*Pounds.*
1	Without potash and with 357 pounds of basic slag	1.20	.....
2	With 89 pounds of potash as potash manure salt	4.53	3.33
3	With 89 pounds of potash as ground feldspar	1.69	.49
4	With 178 pounds of potash as ground feldspar	1.96	.76

These figures show that this soil responded very well to the application of the soluble potash salts. While it must be admitted that the ground feldspar was somewhat available, the effect appears to have been inconsiderable.

It is hard to reconcile such contradictory results as these which are given at length in the preceding pages. The only thing that can be said at the present time is that careful and systematic tests are required in order to determine finally to what extent and under what conditions ground feldspar can be economically used in agriculture. The inference to be drawn would seem to be that under certain conditions finely ground feldspar is at least partially decomposed, so that its potash becomes sufficiently available to be made use of by certain crops. Under other conditions we are forced to the conclusion that ground feldspar is of little value as a potash fertilizer.

Before proceeding with the description of experiments carried on by the Department of Agriculture it will be necessary to define, as briefly as possible, total and available potash, as the terms are commonly used. Potash is the name given to the oxid of the metallic element potassium. The name is derived from the fact that potash at one time was principally obtained by leaching wood ashes in large iron pots. The letter K is used by chemists as the symbol for potassium, the German name for which is Kalium. The oxid is written K_2O, which signifies that two atomic weights of potassium unite with one atomic weight of oxygen to form potash. Potash as such is a strongly caustic substance which unites with water to form a compound technically known as lye. Fertilizers, both natural and artificial, contain potash, invariably combined with some acid to form a compound or salt, such as sulphate, chlorid, carbonate, nitrate, phosphate, or silicate. Although potash (K_2O) does not exist free in a fertilizer, the potassium present in whatever form is figured and reported as total potash (K_2O). Owing to the belief that has

always been held by the majority of chemists and agriculturists that the potash combined as it is in the mineral silicates becomes soluble with extreme slowness, if at all, it is customary to distinguish between available and total potash. According to the official methods in vogue in this country the available potash is determined by boiling 10 grams of the sample with 300 grams of water thirty minutes and analyzing the water extract. In different places different methods are used; in some cases acid solutions are used to extract with, so that it is difficult to give an exact definition of available potash. However, it may be defined as all the potash that is present, in whatsoever form, which the crop can make use of in one crop season. The text-book definitions, as well as the State fertilizer laws, are in need of revision in this particular respect. This is especially true in view of the fact that the value of a mixed fertilizer is figured, as far as potash is concerned, on the available or water-soluble potash alone. Even the potash contained in such organic fertilizers as cotton-seed meal and tobacco stems, which undoubtedly becomes available in one season, is not estimated as being available by the present methods of analysis, and therefore in many cases great injustice is done to manufacturers of mixed fertilizers, who should certainly be entitled to all the plant food contained in their mixtures which can be made use of by a crop in a single growing season.

Tobacco is particularly dependent upon abundant supplies of potash. In some of the tobacco-growing districts barnyard and stable manures are used, often enriched with an addition of commercial fertilizers. Since sulphates and muriates of potash are found to be harmful in certain ways to high grades of tobacco, the use of the strongly alkaline potassium carbonate has been largely resorted to on the tobacco crop. Potassium carbonate, which contains about 66 per cent of potash (K_2O), is an expensive compound, costing \$90 to \$95 per ton, f. o. b. port of entry, or 6 to 7 cents per pound of unit potash. In addition to the cost of this salt, its strong alkalinity is an objectionable feature, and it is a grave question whether the annual addition to the land of a superabundance of such an alkaline salt will not be followed by an actually harmful effect. In view of the successful results which have attended the efforts of the Bureau of Plant Industry[a] to improve the quality and yield of native tobacco by proper selection and breeding, it was decided to make a systematic investigation of the possible use of ground feldspar as a potash fertilizer.

Preliminary to the field and crop experiments which were to follow later, greenhouse experiments were begun early in the winter of

[a] Bul. 96, Bureau of Plant Industry, U. S. Dept. of Agriculture; Yearbook Dept. Agr., 1905, p. 219.

1905–6. Three large beds in the greenhouse, all having the same dimensions ($21\frac{3}{10}$ feet by $6\frac{2}{3}$ feet by 5 inches), were filled with a common unfertilized meadow soil taken from the surface after the removal of sod and grass roots. Four pounds of ground bone phosphate were broadcasted and well worked in.

Bed No. 1 now received 2 pounds of potassium carbonate containing about 67 per cent of potash (K_2O). In order that the potassium carbonate might be evenly distributed, it was dissolved in 2 gallons of water and sprinkled evenly over the bed. After drying out, the earth was again well worked.

Bed No. 2 received 17.4 pounds of finely ground potter's feldspar containing 8.3 per cent of potash (K_2O). This was also broadcasted and well worked in. It will be seen that beds 1 and 2 contained nearly equivalent amounts of potash, the only difference being that in one case the soluble carbonate was used and in the other ground rock.

No potash in any form was added to bed No. 3, which was used for comparison. The soil itself, however, contained about 0.5 per cent of total potash, and as the filtered Potomac River water which it was necessary to use for watering throughout the entire experiment contains an amount of potash equal to about 2 parts per million, the tobacco on bed No. 3 did not at any time show the effect of potash starvation.

All three beds were supplied with a sufficient quantity of nitrogen in the form of pure ammonium nitrate. The seed chosen for the experiments was carefully selected Cuban wrapper tobacco. In making experiments of this kind it is necessary to select seedlings as nearly as possible of equal vigor. It is not improbable that many wrong deductions have been drawn from pot or plat experiments in which the need for careful selection of seed has been overlooked.

Tobacco seedlings were set out in four rows of ten plants each in the three beds. The tobacco crop is usually planted with about 8,000 plants to the acre, so that the experimental plats represented, as far as plant growth was concerned, one two-hundredth of an acre. The actual amount of potash added to plats Nos. 1 and 2 was equivalent to 280 pounds to the acre. As the original soil contained a sufficient amount of potash to mature some sort of a crop on plat No. 3, it is not possible to state the actual amount of potash present in the three plats. The potash in the soil was not water soluble and would not have been termed available in the present sense of the word.

The tobacco grew well throughout the experiment, and for the first six weeks very little difference was noted. After this time, however, it became evident that the plants in plat No. 3 were falling behind. At the end of twelve weeks the plants in plat No. 3 were plainly

stunted and much less developed than those in the other two plats. The tobacco grown in plats Nos. 1 and 2 was evenly developed, fully matured, and of a good quality. It was carefully harvested in the usual way and the yield of green tobacco weighed. After curing, the actual yield of leaf was also recorded. The results, which are shown in the following table, appear to indicate that the feldspar potash was available to quite the same extent as that which was added as potassium carbonate:

TABLE III.—*Results of greenhouse experiments with tobacco plants.*

No. of plat.	Source of potash.	Actual weight of green crop.	Estimated weight of green crop per acre.	Actual weight of cured leaf.	Estimated weight of cured leaf per acre.
		Pounds.	*Pounds.*	*Pounds.*	*Pounds.*
1	Potassium carbonate	154.0	30,800	5.70	1,140
2	Ground feldspar	155.0	31,000	6.30	1,260
3		128.5	25,700	5.30	1,060

These yields do not in any case equal those obtained in the field under the best crop conditions, but for a winter greenhouse crop raised in shallow beds they are satisfactory.

On the completion of the greenhouse experiments arrangements were made to carry on field trials in Connecticut and Florida under standard crop conditions. In the tobacco-growing district of Connecticut it is customary to use from 150 to 250 pounds of carbonate of potash to the acre of tobacco. The cooperation of several prominent tobacco growers was obtained, who each agreed to try an acre, substituting for the usual carbonate 1 ton of potter's spar, running 8.3 per cent of potash, or 186 pounds to the ton. The broadcasting and working in of the feldspar was done under the personal supervision of representatives of the Department of Agriculture, and none of the experimental acres received any potash except that contained in the ground spar. All the experimental fields did as well as any in their neighborhood and matured excellent crops. The following letters were received from the growers themselves in regard to the use of feldspar:

TARIFFVILLE, CONN., *February 11, 1907.*

DEAR SIR: In reply to your letter of February 5, I would say that I used the ton of finely ground feldspar as a potash fertilizer for tobacco, and used no other form of potash on the plat in connection with the feldspar. This plat (one-half acre) was treated exactly like the rest of our tobacco lands as regards nitrogen, phosphoric acid, lime, etc.

We had a fine large growth of tobacco where the feldspar was used; fully as large as any in our fields, and much larger than in some sections of our fields.

I do not consider this an absolute or hardly a fair test of the feldspar, as it was used on land that had previously grown tobacco for several years, and each

year we had fertilized heavily with carbonate of potash. I will be pleased to give you more detail if you wish.

Yours respectfully, J. S. DEWEY.

HARTFORD, CONN., *February 7, 1907.*

DEAR SIR: In reply to your letter of February 5 regarding the finely ground spar, would say that we used this material as a potash fertilizer as directed by you last spring. This was used on comparatively new land, tobacco having been grown only one season previous to this past season. During the growing season we could not see any perceptible difference on the same land between this tobacco and that treated with carbonate of potash, planted side by side. We hung this tobacco in the same shed, it being cut at the same time, where we were able to identify it after it was cured. We are glad to report that the tobacco grown where the ground feldspar was used was exceptionally nice tobacco. It was so pronounced by tobacco experts who have examined it.

The tobacco grown on the same character of land beside where this was grown was exceptionally nice tobacco, but we think if there was any preference it would be for that grown on the feldspar. It certainly was beautiful in every respect. We should be very glad to conduct an experiment on 1 acre or less on new land that has never grown crops of any kind or been fertilized in any way by stable manure or other fertilizer, and follow this up for, say, three years. We have a piece of land we think well adapted to make the experiment. The result this past year has been so gratifying that we would be very glad to carry it a little further, if possible.

Any further information we can give you we will be glad to furnish.

Yours truly, OLDS & WHIPPLE.

SUFFIELD, CONN., *February 16, 1907.*

DEAR SIR: Yours received inquiring about the finely ground feldspar sent me. Would say that I used it on 1 acre of tobacco and got very satisfactory growth. The only difference I could detect in tobacco grown on this acre and the adjoining land, where I used cotton-hull ashes for potash, was that the burn of the tobacco grown on the latter was not quite as clear as that of the tobacco grown on the feldspar.

Yours respectfully, EDMUND HALLADAY.

QUINCY, FLA., *March 7, 1907.*

DEAR SIR: In reply to your favor, I beg to state that 1 acre of tobacco was grown here last year on ground feldspar, and as far as we were able to tell from the appearance of the tobacco in the field the growth was equally as good as where other forms of potash were used. Mr. Underhill, who used this feldspar, was not able to harvest the tobacco separately on account of scarcity of labor in harvest season.

I am planting some plat experiments this year in which I have included the ground feldspar, to be compared with other forms of potash, and hope to get some information in this way. In addition to this I shall put out at least 2 acres of feldspar as a substitute for carbonate of potash, and will report results at the end of the season.

Yours very truly, W. W. COBEY.

Although it is admitted that these experiments have not as yet proved the value of ground feldspar for tobacco, it is quite certain that the experimental crops found all the potash they required. If

we assume that von Feilitzen and others are right and that the feldspar is of little or no value, we must conclude that the practice of adding potassium carbonate each year to the tobacco fields is unnecessary.

Many attempts have been made by the writer to devise crucial tests which would show decisively whether or not the ground feldspar is actually capable of giving up potash to growing plants. One of these experiments, which was undertaken in cooperation with Dr. L. J. Briggs, of the Bureau of Plant Industry, is interesting on account of its direct bearing on this point. A wooden trough of 1 square foot cross-sectional area and 30 feet in length was filled with a poor meadow soil, containing no appreciable quantity of water-soluble potash. About 5 pounds of fine-ground feldspar, containing 9.3 per cent of total potash, was then evenly distributed over the surface of the trough and well worked into the soil. Carbon electrodes of about 1 square foot area were inserted at the extreme ends and tobacco seedlings set out at 1-foot intervals along the trough. The carbon electrodes were connected to a 110-volt direct-current lighting circuit and a current of electricity was passed continuously in the same direction through the soil while the growth of the plants was in progress. The amount of current varied with the moisture content of the soil—between the limits of 5 and 15 milli-amperes. The plants made a flourishing growth, and at the end of several weeks it was apparent that the best growth was being made in the neighborhood of the center of the trough, the plants at the extreme positive and negative ends being more or less stunted. The soil at the beginning of the experiment was neutral to litmus paper. At the end of the experiment, when the plants had attained a maximum height of 2 feet, a sample taken from the positive end of the trough reddened litmus paper, showing it to be decidedly acid. The middle section by the same test was shown to be faintly and the negative end strongly alkaline. While no sweeping deductions can be drawn from the single experiment, it is quite certain that a partial transference of the alkaline bases from the positive to the negative end of the trough had occurred. This effect could only take place with that portion of the bases which had actually passed into solution. The results of this experiment appear sufficiently interesting to warrant repetition under still more careful conditions.

THE EFFECT OF FINENESS OF GRINDING.

From the evidence which has been submitted in the preceding pages it may be safely concluded that the potash contained in ground feldspar is at least in some part available as plant food. The question whether it can be made sufficiently available under certain conditions

to be an economical substitute for concentrated and soluble potash salts remains to be determined by systematic investigation. It may have been noticed in reading the account of the foregoing experiments that in only a few cases was the fineness of the feldspar material described. Each investigator considered ground feldspar fine material, whether it passed an 80-mesh or a 200-mesh sieve. A standard sieve containing 200 meshes to the linear inch has openings 0.0026 inch square. A sieve of 80 meshes to the linear inch has openings about 0.007 inch square. It is never the case, however, that a material which has been ground so that it will just pass a certain sieve will consist of particles of uniform size corresponding to the size of mesh. All ground material contains a certain proportion of very fine particles, down to those which might be characterized as submicroscopic in size. The smaller the coarser particles of a given powder which has been ground in bulk the higher will be the proportion of very fine material. This is a very important point, because it is doubtless true that the amount of decomposition caused by the action of water on ground feldspar is directly proportional to the active surface area presented by unit weights of the powder. To one who has not studied the matter, the rapidity with which surface area rises with fine grinding is very surprising. In a 200-mesh feldspar powder, such as is supplied by the grinder for the pottery trade, the finest particles bear the same relation to the coarsest present as these latter would to fragments about 2 inches in diameter. As the surface area of a powder increases in inverse ratio to the diameter of the particles, it can be seen how quickly the availability due to active surface must increase with fineness in grain. No one would for an instant consider the possibility of fertilizing land by scattering on it feldspar fragments of an average diameter of 2 inches. Yet in grinding these fragments to an 80-mesh powder, we have not increased the active surface area as much as we should do by pushing on the grinding of an 80-mesh powder to the ultimate fineness attainable in mechanical processes. Grinding is making surface, and it can be shown that the availability of potash in ground feldspar increases with the surface area. If feldspar is ground so that it will pass an 80-mesh sieve, it will of course contain a certain proportion of very fine particles, some of which approach the limits of visibility under a powerful microscope. If we carry on the grinding of the material from 80-mesh to 200-mesh, the proportion of the very small particles is enormously increased. The smallest particles which we need to consider here are those which can be measured by a micrometer device connected with the microscope. These smallest particles have a diameter of about 0.0001 millimeter. Now, in order to make a specific example, we will consider the surface areas presented by 1

pound of feldspar in different degrees of subdivision. First, in the form of a solid cube, then broken down to particles that could just pass an 80 and a 200 mesh sieve, respectively, and, finally, in the condition it would be if it were possible to grind all the material as fine as the finest particles which occur in an ordinary 200-mesh powder. The 1 pound of feldspar in a solid cube would have a surface area of 29.3 square inches; particles capable of passing an 80-mesh sieve would give 8,870 square inches; particles able to pass a 200-mesh sieve would give 24,905 square inches; and if it were possible to reduce the powder to particles 0.0001 millimeter in diameter, there would result a surface area of 16,460,000 square inches.

If it were practically possible to collect 1 ton of feldspar all in the state of the finest particles, as shown above, the surface area presented by the ton would be enormous—in fact, it would be equal to 256,000,000 square feet, 5,877 acres, or more than 9 square miles. Now, although such grinding is out of the question at the present time, an ordinary 200-mesh feldspar prepared for the pottery trade, which is valued at about $8 per ton, contains a large proportion of very fine particles. The marvelous rise in the surface area attained by fine grinding is very well exhibited in the figures given, and it is undoubtedly true that previous experimenters have not paid sufficient attention to the percentage of very fine material in the ground feldspar.

One opponent of the use of feldspar has written:[a]

> What we call soil is rock of various sorts crushed or broken up by weather and other agencies. The crushed granite could hardly be more fertile than a good soil. When we think that an acre of soil 1 foot deep weighs over 3,500,000 pounds, we see what a drop in the bucket a few tons of ground rock really amounts to.

As a matter of fact, discussion of the value of a few tons of fine-ground potash-bearing rock, with its millions of square feet of surface area, can not be so easily brushed aside. It is true that the soil contains many fine particles; but those which, like feldspar, suffer decomposition under the action of water have presumably been already decomposed, and this new material is to replace that which has been used up or removed. Each tiny particle of feldspar provides only a small increment of potash, but in a ton of fine-ground material there are many billions of particles.

COST OF GROUND FELDSPAR.

Nearly all of the feldspar which is at present ground to fine powders is prepared, as has been stated, for the pottery trade. For this purpose it is necessary to use mills with specially adapted linings so

[a] The Potash in Crushed Rock, German Kali Works, New York.

that the finished product shall not become contaminated from the contact with iron or steel. The production and cost of feldspar, mainly for the use of the potteries, during five consecutive years, is shown in the following table:

TABLE IV.—*Production and value of feldspar, 1901–1905.*[a]

[Short tons.]

Year.	Crude.		Ground.		Total.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
1901	9,960	$21,669	24,781	$198,753	34,741	$220,422
1902	21,870	55,501	23,417	194,923	45,287	250,424
1903	13,432	51,036	28,459	205,697	41,891	256,733
1904	19,413	66,714	25,775	199,612	45,188	266,326
1905	14,517	57,976	20,902	168,181	35,419	226,157

[a] Mineral Resources of the United States, U. S. Geol. Survey, 1905.

For fertilizer purposes the fine grinding of feldspar could be done in iron mills similar to those which are used for grinding limestone in the cement industry. The only important points to consider would be the percentage of total potash present and the fineness of grinding. At the present time there are few data available on the cost of grinding feldspar to a 200-mesh powder, but with modern machinery there is little doubt that it can be done much more economically than would have been considered possible only a few years ago. Under the stimulus of the cement industry a great development has been made in recent years in the methods and art of fine grinding. The following table is of interest, as it shows at a glance what the potash in ground feldspar would cost if the percentage is compared with a cost of grinding varying from $1 to $10 per long ton.

TABLE V.—*Price per pound of potash unit in feldspar.*

Potash contained in the feldspar.	Cost of ground feldspar per ton (2,240 pounds).									
	$1.	$2.	$3.	$4.	$5.	$6.	$7.	$8.	$9.	$10.
3 per cent	$0.015	$0.030	$0.044	$0.059	$0.074	$0.089	$0.104	$0.119	$0.134	$0.149
4 per cent	.011	.022	.033	.044	.055	.067	.078	.089	.100	.111
5 per cent	.009	.018	.027	.035	.044	.053	.062	.071	.080	.090
6 per cent	.007	.015	.022	.030	.037	.045	.052	.059	.067	.074
7 per cent	.006	.012	.019	.025	.032	.038	.045	.051	.057	.063
8 per cent	.005	.011	.017	.022	.028	.032	.039	.045	.050	.056
9 per cent	.005	.009	.014	.019	.024	.029	.035	.039	.044	.049
10 per cent	.004	.009	.013	.018	.022	.027	.031	.035	.040	.045
11 per cent	.004	.008	.011	.015	.020	.023	.028	.030	.034	.040
12 per cent	.004	.007	.011	.015	.018	.022	.026	.029	.033	.037
13 per cent	.003	.007	.010	.014	.017	.021	.024	.027	.031	.034
14 per cent	.003	.006	.010	.013	.016	.019	.022	.026	.029	.032
15 per cent	.003	.006	.009	.012	.015	.018	.021	.024	.027	.030

The prices are given in cents per pound, so that if, for instance, rock carrying 8 per cent of potash could be delivered for $9 per ton, the potash contained in it would be added to the land at a cost of 5

cents per pound. At $5 per ton the cost per pound would fall to 28 mills. The figures are of course only applicable provided the potash in the ground material can be proved available as a plant food.

It must be remembered that the only real measure of available potash is that which is made use of by the crop. It is not likely that all the potash added, even in the form of soluble potash salts, is actually used, and the amount that can be supplied by ground rock is still an unknown quantity.

POSSIBLE HARMFUL EFFECTS OF GROUND FELDSPAR.

The question is frequently asked whether there is possible danger to the land in experimenting with the use of ground feldspathic rock. It is well known that in some cases, notably with tobacco, injurious effects are produced by the continued use of the soluble potash salts, particularly the sulphate and muriate. Feldspar grains of various sizes are normally present in many soils; it does not, therefore, seem possible that any harmful effect could follow the application of ground rock. As has been pointed out in an earlier portion of this paper, feldspar consists of the alkaline elements, soda, potash, and lime, combined with alumina and silica. After decomposition, hydrated aluminum silicate, the essential base of all clays, is left behind, the alkalis and the silica being set free in a condition in which they can be absorbed by the root action of plants. It would seem, therefore, that whatever the value of the results obtained no possible harm can follow the experimental use of ground feldspar in reasonable quantities.

EXTRACTION OF POTASH FROM GROUND ROCK.

The discussion of the use of ground rock as a source of potash is not complete unless it includes the extraction of potash by chemical and electrical processes. If future experiments should demonstrate that fast-growing crops are dependent on very soluble forms of potash the question of the extraction of this element from ground feldspar becomes a matter of importance.

The extraction of potash from rock has not as yet been accomplished on a commercial basis, but it has been done in the laboratory, and the method has been published in a recent bulletin.[a] The full details of the investigation are too technical for insertion here, but if the processes described could be carried on at a cost low enough, the potash in ground rock could be rendered sufficiently soluble for all practical purposes. Briefly, the method consists in sliming the ground feldspar with water to which a small quantity of hydrofluoric

[a] Bul. 28, U. S. Dept. of Agriculture, Office of Public Roads.

acid has been added. This slime is placed inside a suitable wooden vessel and a current of electricity is passed through it. The alkali set free by the action of the acid is carried away by the electric current, while the acid appears to be used over and over again. Finally, by combining the acid and alkaline products, a material is obtained in which the potash which has been set free is soluble and available. It is hoped that further investigation will result in some method based on these principles for making the vast quantities of potash contained in feldspathic rocks completely available.

CONCLUSION.

A careful reading of the foregoing pages will show that no claim has been made that ground feldspar is an efficient substitute, under all circumstances, for potash salts. The effort has been to present all the evidence which could be collected, both for and against the use of ground feldspar as a fertilizer. The question is still open, and systematic and long-continued experimentation is the only possible method of obtaining conclusive information on the subject. The evidence so far obtained appears to indicate that under certain conditions and with certain crops feldspar can be made useful if it is ground sufficiently fine. On the other hand, it is highly probable that under other conditions the addition of ground feldspar to the land would be a useless waste of money. At the present stage of the investigation it would be extremely unwise for anyone to attempt to use ground rock, except on an experimental scale that would not entail great financial loss.

The subject must be approached conservatively, with due regard to business economy. Sensationalism and exaggeration invariably do harm. It is extremely unlikely that ground rock will ever entirely displace the use of potash salts, for its availability must inevitably depend upon many modifying conditions, such as the nature of the soil, the amount of moisture present, the character of the other fertilizers used, and the varying root action of different crops. With tobacco the results so far obtained have been encouraging, but it is possible that this plant, which is a voracious feeder, can make use of the potash in fine-ground feldspar to a greater extent than other fast-growing crops, such as potatoes and the cereals, some of which mature in practically sixty days and must therefore find their plant food in a highly available condition.

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U. S. DEPARTMENT OF AGRICULTURE.

BUREAU OF PLANT INDUSTRY—BULLETIN NO. 105.

B. T. GALLOWAY, *Chief of Bureau.*

THE RELATION OF THE COMPOSITION OF THE LEAF TO THE BURNING QUALITIES OF TOBACCO.

BY

WIGHTMAN W. GARNER,

SCIENTIFIC ASSISTANT, TOBACCO BREEDING INVESTIGATIONS, BUREAU OF PLANT INDUSTRY.

ISSUED JUNE 8, 1907.

WASHINGTON:

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1907.

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U. S. DEPARTMENT OF AGRICULTURE.

BUREAU OF PLANT INDUSTRY—BULLETIN NO. 105.

B. T. GALLOWAY, *Chief of Bureau.*

THE RELATION OF THE COMPOSITION OF THE LEAF TO THE BURNING QUALITIES OF TOBACCO.

BY

WIGHTMAN W. GARNER,

SCIENTIFIC ASSISTANT, TOBACCO BREEDING INVESTIGATIONS, BUREAU OF PLANT INDUSTRY.

NEW YORK BOTANICAL GARDEN

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LETTER OF TRANSMITTAL.

U. S. Department of Agriculture,
Bureau of Plant Industry,
Office of the Chief,
Washington, D. C., April 13, 1907.

Sir: I have the honor to transmit herewith a manuscript entitled "The Relation of the Composition of the Leaf to the Burning Qualities of Tobacco," by Dr. Wightman W. Garner, Scientific Assistant in the Tobacco Breeding Investigations of this Bureau.

This paper contains much information of importance to growers, manufacturers, and tobacco breeders on points which have heretofore been very imperfectly understood. I would therefore recommend the publication of the manuscript as Bulletin No. 105 of the series of this Bureau.

Respectfully,

B. T. Galloway,
Chief of Bureau.

Hon. James Wilson,
Secretary of Agriculture.

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B. P. I.—285.

THE RELATION OF THE COMPOSITION OF THE LEAF TO THE BURNING QUALITIES OF TOBACCO.

INTRODUCTION.

Of the many requirements for a first-class smoking tobacco, whether for pipe or cigar, good burning qualities may be said to be most important. Not only are these essential in themselves, but the character of the combustion and the conditions under which it takes place constitute one of the principal factors which control the aroma. The widest variation is found among samples of tobacco as regards the burning qualities, and it frequently happens that an entire crop of the best quality in other respects is rendered almost valueless because it will not burn. The ultimate cause of this variation in burning qualities must be sought in differences in chemical composition. Experience has shown that the chemical composition of tobacco, as reflected in its burning qualities, is greatly influenced by the character of the soil, the climate, wet and dry seasons, and the kind of fertilizers applied to the soil. Moreover, there is good reason to believe that certain strains or types of tobacco possess the power of appropriating from the soil those constituents conducive to a good burn, while other closely related types under the same conditions are lacking in this power.

It is evident, therefore, that an accurate knowledge of the chemical characteristics of good and bad burning tobaccos is of fundamental importance in deciding upon the proper selection of soils and fertilizers in order to get the best results. It is highly probable also that such information would prove of great assistance in tobacco breeding in establishing strains possessing specially good burning qualities. Finally, it is well known that independently of the successful growing of a good tobacco crop the curing and fermentation are important factors in developing a good burn, and with a more complete knowledge of the chemical changes taking place in these processes further improvements in the methods now in use may be expected, for with better information as to the changes to be effected it will be much easier to develop the best methods for obtaining these results.

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As applied to tobacco, the term "burning qualities" is a comprehensive one, including several different elements, chief of which are the fire-holding capacity, the evenness and completeness of the burn, and the character of the ash. The fire-holding capacity refers simply to the length of time the tobacco will continue to burn. Frequently samples of tobacco which possess a satisfactory fire-holding capacity show a tendency to carbonize, or "coal," in advance of the burning area and will not burn evenly. In some cases these defects appear to be due to injudicious combinations of the three component parts of the cigar, namely, the filler, the binder, and the wrapper; in other cases the cause lies in the chemical composition of the leaf. As to the quality of the ash, the important characteristics are the color and the firmness or cohesiveness. There is an essential difference between the combustion of most substances and the burning of tobacco. In the first case, the substance when ignited burns with a flame, and as soon as the flame is extinguished the combustion ceases. On the other hand, tobacco of good quality will not burn with a flame, but will continue to glow almost indefinitely.

It may be said in general that those substances which show the greatest tendency to burn with a flame have the least capacity for glowing, and vice versa, and this rule is applicable to different kinds of tobacco, for in cases of very rank growth where the leaf is thick and coarse or in any tobacco markedly deficient in mineral constituents there is a decided tendency to burn with a flame, whereas the capacity for glowing is lacking. The differences in the two kinds of combustion are well illustrated by the case of coal and its decomposition products when subjected to dry distillation. The volatile products, the larger portion of which goes to make up the illuminating gas, are inflammable, while the residual coke, consisting essentially of carbon, yields no flame when burned, but under favorable conditions will continue to glow until consumed. Now, in the burning cigar these two processes are both going on simultaneously and more or less independently of one another. The organic constituents of the leaf in the region immediately in advance of the burning area are undergoing the process of dry distillation, in which the volatile products for the most part escape and appear in the smoke. Moreover, it is this process which gives rise to the aroma. As the fire advances, the residue from the distillation, which consists of the mineral constituents of the tobacco, together with more or less carbon and stable organic condensation products, becomes incandescent, and the glow continues until practically all of the combustible matter is consumed, leaving as the final residue the ash. If certain of the mineral constituents of the tobacco which interfere with the combustion predominate, the resulting ash will be dark in color, while if

others which favor the complete combustion predominate, the ash will be white, or very nearly so.

From what has been said it is perhaps not surprising that the relation of the chemical composition to the burning qualities of tobacco early attracted the attention of agricultural chemists, and this problem has led to a large number of purely chemical investigations, as well as practical field experiments. But although more than fifty years have elapsed since the publication of the first important paper on the subject, by Schlösing, no one has as yet been able to offer a satisfactory explanation of the conduct of different kinds of tobacco as regards their burning qualities. Many theories have been put forward from time to time, but they have all proved to be either fundamentally erroneous or inadequate to explain all the facts. Except a few general relations which have been pretty fully established, the results obtained by different investigators have led to widely different and oftentimes contradictory conclusions. It will not be necessary to discuss or even mention here all the work which has been published on this important subject, and only those facts which seem to be best supported will be briefly reviewed.

In comparing the composition of the tobacco plant with that of other agricultural crops, the most striking characteristic is its remarkably high content of mineral matter, commonly spoken of as the ash. In some cases the ash content reaches 25 per cent of the total weight of the dry tobacco leaf, and the average is well above 15 per cent. For this reason by far the greater portion of the work of chemists on tobacco has been devoted to the study of the composition of this ash.

Broadly speaking, there are two methods of attacking the problem of the relation of the composition to the burn, one of which may be called the analytical and the other the synthetical. Nearly all of the investigations on this subject fall under the head of the analytical method, which consists simply in making comparative analyses of samples of tobacco having good and poor burning qualities, and attempting to trace the relation between the differences in composition and the good and bad burning qualities. An examination of the composition of a typical tobacco ash will show how extremely difficult it is to draw any positive conclusions from any set of analyses which will not be subsequently contradicted by other analyses.

In the first place, there are present in tobacco three inorganic acids and three bases, all of which occur in sufficient quantities to exert an important influence on the burn and all of which are subject to wide variations in quantity in different tobaccos. With such complex variations it is almost impossible to single out those differences which really exert determinative influences on the burn. But more impor-

tant still, with so many acids and bases present in the leaf, there is the possibility of very considerable differences in the distribution of the latter among the former, and in some cases these differences would certainly exert a very important influence on the burning qualities. It is quite impossible, however, to obtain any information as to the way in which the bases are distributed between the acids in different tobaccos by any available methods for the analysis of the ash. A very large number of analyses have been made of the ash of various sorts of tobacco grown in different parts of the world, but no one has been able to point out any constant relation between the varying quantities of the constituents of the ash and the differences in burning qualities.

It is to be regretted that in all these analyses no attempt has been made to distinguish between the sulphur existing in the plant as sulphate and that combined with organic compounds, although it has long been recognized that both forms are actually present, and in the case of some plants it has been found that the content of organic sulphur is much greater than that of sulphates. By the methods commonly used in the preparation of the ash for analysis, varying proportions of this organic sulphur are oxidized to sulphuric acid, while the remainder is lost: hence such analyses are valueless as a measure of the quantity of sulphate originally contained in the sample.

As opposed to the method of directly analyzing samples of tobacco with good and bad burning qualities, what may be called the "synthetical method" consists in determining the effect on the burn of adding to tobacco or some other suitable substance those compounds normally occurring in the leaf. It is difficult to get quantitative results in this way, but, on the other hand, positive results in a qualitative way can be obtained, which in the case of any one constituent added are largely independent of the effects of the other constituents. In this way conclusions are based on direct experiment and do not depend on the differentiation of several factors operating simultaneously and perhaps in opposite directions.

Schlösing[a] was the first investigator to study the problem by this method. He showed that the fire-holding capacity is not proportional to the amount of potassium nitrate, and concluded that potash in combination with organic acids is the principal factor favoring this property. If the potash is combined with sulphuric acid and chlorin and the organic acids are in combination with lime, a poor burn results; hence a tobacco with good burning qualities contains potash in excess of that equivalent to the sulphuric and hydrochloric acids. Schlösing attributed the beneficial action of the potash salts

[a] Landw. Vers. Stat., 3, 98.

of the organic acids to their peculiar property of swelling up to many times their original volume and thus yielding a porous mass of finely divided carbon when decomposed by heat.

Nessler[a] made a large number of experiments on the effects of various salts on the glowing capacity of filter paper, his method being simply to impregnate strips of the paper with solutions of the salts of definite strength. His principal conclusions are (1) that potash, especially in the form of sulphate and carbonate, acts very favorably on the fire-holding capacity, while lime and magnesia exert no marked effect except to whiten the ash; (2) that chlorids are very injurious, and (3) that potassium nitrate gives a quick but incomplete combustion, while calcium and magnesium nitrates act very favorably. Nessler admits that the organic potash salts favor the fire-holding capacity, but combats the theory of Schlösing in explanation of their favorable action. He points out that the ease with which these salts are decomposed by heat leads to carbonization, or "coaling," of the tobacco in advance of the burning area, which is a very undesirable property; and, moreover, that potassium sulphate, entirely lacking the property of swelling and yielding a carbonaceous residue when heated, also exerts a markedly beneficial influence on the fire-holding capacity. Nessler assumes that the favorable action of potash salts is due to the formation of a small amount of free potassium during the combustion, which serves as an energetic oxygen carrier; or, in other words, it is simply a catalytic action.

Mayer[b] has supplemented this work by including in his experiments many organic compounds, and concludes in general that these latter favor the burning with a flame, while they decrease the glowing capacity. The inorganic salts in general, especially those of potassium, favor the glowing capacity.

Nessler and Mayer based their conclusions on the supposition that the compounds tested would exert the same influence on tobacco as on filter paper, but this is by no means the case. The chief reason for this appears to be in the relative sensibility of filter paper and tobacco toward the salts affecting the glowing capacity. Filter paper, which is almost pure cellulose, is extremely sensitive toward metallic salts, and when moistened with a solution of any of the potash salts containing even as low as .25 per cent of potash will continue to glow indefinitely, while, on the other hand, ten times this quantity may entirely destroy this property. Tobacco contains, besides cellulose, many other organic substances which are far less combustible, and hence requires much larger quantities of these salts to produce appreciable effects on the burning qualities. For example, small quantities of potassium chlorid greatly improve the glowing capacity of

[a] Landw. Vers. Stat., 19, 309. [b] Landw. Vers. Stat., 38, 126.

filter paper, but when applied to tobacco in sufficient quantities to influence the burn the effect is very injurious. Conclusive results can not therefore be obtained by the use of filter paper alone; nevertheless they are of value as supplementing the test applied directly to the tobacco.

Dr. E. H. Jenkins [a] determined the amounts of potassium carbonate in the ash of a number of different types of tobacco, which is a rough measure of the quantities of organic potash salts originally present in the unburned tobaccos. No constant relation was found to exist between the amount of carbonate and the fire-holding capacity, and Jenkins concludes that the burning qualities are largely influenced by the organic constituents of the tobacco.

Van Bemmelen [b] maintains that the glowing capacity is governed by the relative quantities of alkali and of hydrochloric and sulphuric acids—expressed in chemical equivalents—in the tobacco. In good-burning samples the potash is largely in excess of the acids, while in the bad-burning samples the acids are equal to or in excess of the alkali. Apparent exceptions to this rule are explained by the assumption that the potash may be partly replaced by lime and magnesia. This theory appears to be the nearest approach to the true explanation of the cause of the good and bad burning qualities of tobacco of any yet offered, but the assumption that the favorable influence of the potash on the burn may be also exerted to any considerable extent by lime and magnesia under certain conditions is contrary to the evidence bearing on this point.

Fesca [c] from his studies of Japanese tobacco, concludes that chlorin and sulphur have a very unfavorable influence on the burn, but phosphorus is indifferent.

Barths [d] agrees in general with the conclusions reached by Nessler and Mayer, and believes that the beneficial effect of potash salts are produced by the reduction of the potash compounds to potassium oxid and free potassium, which serve as energetic oxygen carriers, as was suggested by Nessler. The injurious effects of certain inorganic salts are due either to their nonreducibility or to their easy fusibility. The alkali phosphates are regarded as particularly injurious because of their easy fusibility.

Summarizing the results obtained by the investigators mentioned, it is evident that the only two facts which have not been disputed are (1) that chlorin injures the fire-holding capacity and (2) that potash favors this property.

The effects of sulphates and phosphates and the relative value of the different salts of potash in promoting the fire-holding capacity

[a] Ann. Rpt. Conn. Agr. Expt. Sta., 1884, p. 96.
[b] Landw. Vers. Stat., 37, 409.
[c] Landw. Jahrb., 1888, 329.
[d] Landw. Vers. Stat., 39, 81.

are disputed points. The same is true also of the effects of lime and magnesia on the burning qualities. The two facts which have not been contradicted are insufficient in themselves to explain the burning qualities of different samples of tobacco, for it rarely happens that tobacco contains enough chlorin to produce any injurious effects, and it frequently happens that samples very rich in potash have a poor burn, while others comparatively poor in this constituent show excellent burning qualities.

It seemed quite possible that some further light might be thrown on the subject by extracting different samples of tobacco with various solvents and noting the effect on the burning qualities. It should be stated here that all samples of tobacco used in the experiments described in this paper had been thoroughly fermented, and the results are not intended to be applied to unfermented tobacco. Extraction of various samples with petroleum ether and with ordinary ethyl or sulphuric ether did not appreciably affect the burning qualities. When strong alcohol was used as the solvent the same result was obtained, except in a single case, where the fire-holding capacity was considerably improved by the extraction.

More striking results are obtained when tobacco is extracted with water. The following simple experiment is very interesting and instructive: A leaf of tobacco having a good glowing capacity is divided along the midrib into two parts, one of which is extracted for forty-eight hours with a comparatively large volume of distilled water. After being dried the extracted portion of the leaf will be found to have entirely lost its glowing capacity. Now, if the extract be evaporated down to a very small volume and a bit of the extracted leaf saturated therewith and dried, it will once more show a good fire-holding capacity. Whether this is less or greater than the original leaf possessed will depend, of course, on the concentration of the extract. This extract will further impart a good burn to filter paper and to other samples of tobacco showing poor burning qualities. This simple experiment seems to prove conclusively that the active principle or principles in imparting to the tobacco leaf its capacity for holding fire can be extracted with water.

The problem, then, is to determine the composition of the extract and to discover which of its constituents contribute to the burning qualities of the tobacco. One hundred grams of tobacco having a good burn were extracted with 1 liter of distilled water; the extract was poured off and the tobacco again extracted with the same quantity of water for twenty-four hours longer. The extracts thus obtained were combined, filtered, and evaporated to about 150 c. c. During the evaporation a considerable quantity of calcium citrate separated out, which was removed by filtration. The filtrate was

made up to 200 c. c. and aliquot portions were taken for analyses. The principal constituents of the extract are the chlorid, sulphate, nitrate, citrate, and malate of potassium, together with ammonium and nicotine salts and small quantities of lime and magnesia. For comparison, the ash of the extracted tobacco was also examined and it was found that practically all of the phosphoric acid, about one-half of the magnesia, all of the oxalic acid, and the greater portion of the lime remain in the leaf, while the extract contains nearly all the chlorin, all the potash, malic, citric, and nitric acids, and most of the sulphuric acid. About one-half of the total ash is extracted from the leaf by this process, and this seems to contain all the constituents which impart to the tobacco the capacity for holding fire.

An extract of a tobacco having poor burning qualities was prepared in the same way, and it also showed the power to impart the capacity for holding fire, but as nearly as could be measured this power was only about one-fifth of that shown by the extract from the tobacco having good burning qualities. It differed from the latter as regards composition in that it contained about five times as much sulphuric acid, twice as much magnesia, and considerably less nitric acid. The total quantity of potash was about the same in the two extracts, so that the extract from the tobacco with poor burning qualities contained much less potash in combination with the organic acids. The difference in composition of these extracts, then, obtained from tobaccos having good and bad burning qualities, indicates that the principal factor favoring the burn is the potash in excess of the amount required for combining with the mineral acids.

EFFECTS OF THE VARIOUS CONSTITUENTS OF THE ASH ON THE BURNING QUALITIES OF TOBACCO.

The experiments previously described show conclusively that those compounds which are most important in promoting the burn of tobacco can be removed by extraction with water; but the water extract is a complex mixture of salts, and it is therefore desirable to determine the relative effects of each of these constituents. In order to do this, solutions of certain definite strength were prepared of all of the salts which are found in the extract, and the effects of all these on the burning qualities of various samples of tobacco when applied singly or in combination were noted. In testing the effects of any one base combined with the different acids the solutions were all made of such strength that the quantity of the basic element was always the same, regardless of the molecular weights of the salts used in the experiments. The salt solutions were applied to small strips of the leaf, either by placing them in a watch glass and pouring over them a quantity of the solution to be tested just sufficient to thor-

oughly saturate them, thus avoiding any leaching out of the soluble constituents of the leaf, or by spraying the strips and allowing them to stand in a moist atmosphere until the solution had diffused through the leaf. In every case a strip of the leaf adjoining the portion treated with the solution was reserved for comparison. The tests on different samples of tobacco did not always agree, as was to be expected, since the quantities of the various salts already present in the leaf are subject to wide variation, and these differences in some cases may overshadow the effects of the salt added. For the same reason the concentration of the solution added must be taken into account. To overcome these factors it is necessary to apply each test to a number of different samples of tobacco. The tests on tobacco were always further supplemented with similar experiments on strips of filter paper.

There are three base-forming elements which occur in tobacco in sufficient quantities to require consideration—potassium, calcium, and magnesium—while the important mineral acids are sulphuric, phosphoric, hydrochloric, and nitric, and the chief organic acids are citric, malic, and oxalic. Little is known of the actual distribution of the three bases among the acids and so it is necessary to test all of the possible combinations. It is probable, however, that the sulphuric, nitric, and hydrochloric acids are for the most part combined with potash so far as the quantity of this base present will suffice to neutralize these acids and that any excess of potash would be in combination with the organic acids. All of the oxalic acid appears to be combined with lime. If the acids and bases were allowed to interact in the presence of water, the distribution of the latter among the former would be controlled simply by the relative solubilities of the resulting salts and the strengths of the acids and bases; but during the life processes of the plant, which do not cease until some time after the tobacco has been placed in the curing shed, other forces come into play, and it hardly seems probable that there is sufficient water left in the leaf after the life activities have ceased to permit of a readjustment between the acids and bases according to purely chemical forces.

POTASSIUM.

All the salts of potassium are soluble, so that there is no difficulty in testing the salts at any desired concentration. Those most used for applying the tests to tobacco contained 1 per cent and 2 per cent, respectively, of potassium, while for tests with filter paper much weaker solutions gave the best results. In the case of the chlorid it was found that the addition of comparatively large quantities practically destroyed the burning qualities of tobacco, while moderate amounts caused very incomplete combustion, leaving a heavy black

residue. While chlorin is undoubtedly injurious, these experiments all indicated that it requires larger quantities to seriously affect the burning qualities than is commonly supposed. The sulphate, when added in any considerable quantity, invariably injured the burning qualities very markedly, acting in this respect very much like the chlorid but to a lesser degree. The conclusion reached by Nessler that potassium sulphate is highly beneficial, which was based on experiments with filter paper, is thus shown to be erroneous. Potassium nitrate in large quantities causes tobacco to burn explosively and the combustion is incomplete; in smaller quantities it exerts a distinctively beneficial action, but not more so than some other potash salts. The quantity of potash combined with nitric acid in tobacco is generally comparatively small, and other forms of potash are more important in promoting the fire-holding capacity. As regards the phosphates, only the dipotassium salt need be considered, and this appears to be practically neutral in its action, neither promoting nor hindering the fire-holding capacity. Moreover, as compared with the other important acids the quantity of phosphoric acid is nearly always small. The oxalate, citrate, malate, and acetate of potash all showed very beneficial effects in every case, though much larger quantities were required for some samples of tobacco than for others. Excessive amounts of these salts, on the other hand, injured the burning qualities, especially as regards the character of the ash. Also when applied to filter paper in small quantities the latter acquires a good fire-holding capacity, whereas large amounts again destroy this property. The acetate is considerably less efficient in improving the fire-holding capacity than the other three organic salts, probably on account of its greater stability.

CALCIUM.

Considerable difficulty is met with in getting accurate tests with the calcium salts because nearly all of them are difficultly soluble, and hence solutions can not be obtained of sufficient strength to give decided results. Only the chlorid, nitrate, and acetate are easily soluble, and of these the nitrate shows an anomalous conduct, and so the results obtained with this salt are not specially significant. In the case of the insoluble salts, emulsions were applied to the tobacco, but of course results obtained in this way are not as reliable as those secured by use of solutions. The chlorid of calcium is very injurious to the fire-holding capacity and decidedly more so than the potassium salt, so that even small quantities destroy this property. Calcium sulphate in moderate quantities injures the burn markedly and to a greater extent than the corresponding potassium salt. The effect of the nitrate of calcium on the burn is somewhat surprising. If a

sample of tobacco with good burning qualities is saturated with a 10 per cent solution of the nitrate and dried, it burns with extreme rapidity, almost explosively, and gives a remarkably white ash, while with samples of tobacco with poor burning qualities scarcely any beneficial effects are produced. More dilute solutions, such as were used in the case of the other salts, do not produce any appreciable effects. Moreover, it requires a concentrated solution to impart to filter paper a good fire-holding capacity. It seems likely that the effects of the concentrated solution on the tobacco with the good burning qualities are due largely to reaction of the calcium nitrate with potash salts in the leaf. So far as could be determined no marked effects are produced by adding calcium phosphate to tobacco. The acetate of calcium is of special interest because it is readily soluble and thus furnishes an opportunity of comparing the relative effects of potassium, calcium, and magnesium on the burning qualities. Of a large number of samples of tobacco tested a few were improved by the acetate, but the greater number were scarcely affected as regards the capacity for holding fire. In every case, however, the color of the ash was very materially improved. None of the remaining salts of calcium to be considered are easily soluble, but so far as could be determined they neither injure nor improve the fire-holding capacity to any considerable extent, but all give a decidedly whiter ash.

MAGNESIUM.

All the salts of magnesium are readily soluble except the phosphates, and so it is much easier to get satisfactory results with them than is the case with the calcium compounds. The chlorid and sulphate are both very decidedly injurious to the burn, and the addition of even small quantities will destroy the glowing capacity of tobacco having the very best burning qualities. The sulphate is much more injurious than the corresponding calcium salt. The nitrate acts very much like the calcium compound, but its action when applied in concentrated solution is less marked. When applied to filter paper it shows the peculiar property of charring the paper in wave-like forms much in advance of the burning portion. The phosphate of magnesium appears to be more injurious to the burn than the corresponding calcium compound. The acetate was found to injure the burning qualities in every case, but to a lesser extent than the inorganic salts. The citrate, malate, and oxalate in a few cases did not interfere with the burn, but in the greater number harmful effects were observed. All of the salts of magnesium, like those of calcium, tend to produce a white ash.

MINERAL AND ORGANIC ACIDS.

In describing the results of the tests with the various salts these have been grouped under the heads of the three bases, potassium, calcium, and magnesium, but it is also instructive to consider them arranged according to the acids with which these bases are combined.

Chlorids.—All of the chlorids injure the burn, but that of potassium much less than the calcium and magnesium salts.

Sulphates.—All of the sulphates injure the fire-holding capacity, but to very different degrees. The potash salt is decidedly less harmful than that of calcium, while the magnesium compound is remarkably injurious, being comparable with the chlorids in this respect.

Nitrates.—The potash salt is very favorable to the burn, but the calcium and magnesium compounds produce little effect except when present in very large quantities.

Phosphates.—Dipotassium phosphate is practically neutral in its effect, while the calcium and magnesium salts are somewhat harmful.

Salts of organic acids.—The potassium salts are very favorable to the burn, the calcium salts are slightly beneficial, and the magnesium salts are somewhat injurious.

It would seem from these results that the effect on the fire-holding capacity of any element entering into the composition of the ash depends more on the nature of its combination than on the quantity which is present. In the case of sulphuric acid, for example, a considerable quantity combined with potash would not seriously injure the glowing capacity, while even a small amount of it in combination with magnesium would entirely destroy this property. Again, the organic acids when combined with potash are very beneficial, but in combination with magnesia their favorable influence entirely disappears.

It is evident that the one element on which the fire-holding capacity is entirely dependent is potassium. But it is equally essential that part of the potash be in combination with organic acids, for it is to this form chiefly that its beneficial action is due. The nitrate of potash when present in considerable amounts undoubtedly contributes also to this property. Schlösing, as has been said, attributed the beneficial effects of the organic potassium salts to the peculiar property which they possess of swelling up to many times the original volume when decomposed by heat, thus leaving a very porous, finely divided residue of carbon, which continues to glow until combustion is complete. This explanation, however, is inadequate, for there are other salts which promote the glowing capacity but do not yield the carbonaceous residue when heated.

It will be observed that all the potash salts which favor the property of glowing, including the nitrate, yield in the combustion the

carbonate. It was found, in fact, that the carbonate itself is just as efficient in imparting the property of glowing to tobacco as the organic salts, and the same is true of the bicarbonate. This fact points strongly to the conclusion that the favorable action of the potash salts is dependent on the ease with which they yield the carbonate. It seems possible that the carbonate or bicarbonate by alternately giving off and taking up carbon dioxid may serve as a means of removing this gas at the most favorable moment, the effect being somewhat the same as when nitrates render organic substances combustible by supplying oxygen in a highly concentrated state. It may be, however, that the potassium oxid formed from the carbonate is further reduced to the metallic state by the highly heated carbon, thus serving as an energetic oxygen carrier, as was suggested by Nessler. Whatever may be the peculiar properties of these potash salts which give them the power of imparting the property of glowing to tobacco, it is certain that these properties are not shared by the salts of calcium and magnesium except to a very limited degree.

While the inorganic salts of calcium are injurious to the fire-holding capacity, the compounds of this base considered collectively may be said to be inert with reference to this quality. The compounds of magnesium are all injurious, but the harmful effects are greatly reduced when the magnesium occurs in combination with the organic acids.

The question has often been raised whether lime and magnesia may not, in part at least, replace potash without injuring the burning qualities. Many ash analyses which have been made seem to indicate that this is the case, while others point to the opposite view. This assumption is made by Van Bemmelen [a] to explain the fact that in some samples of tobacco which show a good fire-holding capacity the total quantity of potash is only very slightly in excess of that necessary to neutralize the sulphuric and hydrochloric acids. But Van Bemmelen's calculations are all based on the ash analyses, and it has been pointed out that the estimation of the sulphuric acid in the ash gives no indication of the quantity of sulphur actually present in the tobacco in the form of sulphates and therefore that the amount of potash in organic form may be considerably greater than calculations based on these data would indicate.

In so far as lime alone is concerned the conclusion to be drawn from our experiments is that this can only replace part of the potash when the latter is present in combination with organic acids in quantities larger than are necessary to produce a good burn; for while organic salts of lime do not appear to injure the fire-holding capacity, they do not specially favor it. The amount of potash in organic form

[a] Landw. Vers. Stat., 37, 409.

necessary to impart the property of glowing to tobacco no doubt is influenced to some extent by variations in the other organic constituents of the leaf, but our experiments have shown that excessive quantities of these salts tend to injure the burn by causing a too rapid combustion. It may happen, therefore, that a sample of tobacco contains more organic potash than is necessary to produce the best burn, and in such cases a portion of it could be replaced to advantage by lime. Since magnesia compounds as a whole tend to injure the burn it seems certain that the replacement of potash to any considerable extent by this element would seriously injure the burning properties.

For purposes of experimentation looking to the production of tobaccos possessing superior burning qualities, either by means of fertilizers and improved methods of curing and fermentation or by breeding and selection, it is very desirable to have at hand some method of testing the results by chemical examination. This is especially true because of the complexity of conditions which influence the qualities of tobacco. For example, if the attempt is made to improve the burning qualities by the use of certain potash salts, with a view to increasing the amount of potash in organic form in the tobacco, the result of the experiment may be entirely obscured by extraneous factors, such as improper curing and fermentation, if the fire-holding capacity alone were determined. Of course, in this particular case chemical analysis would reveal whether the object sought had really been attained, but there are other questions of chemical composition pertaining to this problem which can only be measured with difficulty by the methods at present available. This is especially true of the manner in which the bases are distributed among the acids in tobacco and whether this distribution is essentially different in different samples.

All of the important organic acids, and also nitric acid, when combined with potash seem to be about equally efficient in promoting the fire-holding capacity. Oxalic acid, however, is probably always combined with lime and so it is of little value in this connection. Since a portion at least of the potash combined with organic acids, as well as that present in the form of nitrate, will appear in the ash of the tobacco as carbonate, the determination of this latter quantity gives a rough measure of the amount of these salts originally present and is therefore by far the most important single criterion for judging the burning qualities in a chemical way.

We have tested a number of samples of tobacco grown in Connecticut in this way, in each case using one half of the leaf for testing the alkalinity of the ash and the second half for finding the fire-

holding capacity. To obtain some indication as to whether lime and magnesia can partly replace the organic potash, the alkalinity of the ash due to these bases was also determined, but the evidence on this point was all of a negative character, for the alkalinity due to lime and magnesia collectively did not show any apparent relation to the glowing capacity. In the case of the alkalinity due to potash—that is, the quantity of the potassium carbonate—however, there is unmistakable evidence of a close relation between these values and the capacity for holding fire, and if the method were really a true measure of the organic potash it is believed that there would be very few, if any, exceptions to this rule.

The samples used for this test were selected with special reference to the tobacco-breeding experiments which are being carried on by the Bureau of Plant Industry, and were taken from crops produced from the seed of individual selections of four different types of tobacco originally found growing in the same field. Both the light and the dark wrappers were examined in each case, and in every instance the former as compared with the latter showed a much greater fire-holding capacity and a much higher percentage of potassium carbonate in the ash. Also as regards the same grade of leaf of the different strains of each type, as well as of the different types taken collectively, the potash alkalinity was found to be directly proportional in nearly every case to the capacity for holding fire. This was especially true of the different strains of any one type. These tobaccos were all grown under as uniform conditions as could be obtained with reference to soil and fertilizers, and the results make it very probable that certain types or strains of tobacco possess the power of appropriating potash in forms favorable to the burning qualities to a greater degree than others growing under the same conditions, though further data are required to fully prove this point. The question is certainly a very important one from the standpoint of practical tobacco breeding and is worthy of very careful study.

THE CHARACTER OF THE ASH.

A tobacco with satisfactory burning qualities besides having the necessary capacity for holding fire must also yield a good ash. Although the organic potassium salts greatly favor the fire-holding capacity, they tend to produce a mottled, dark-colored ash. This is no doubt due to the easy fusibility of the alkali carbonate, which in melting incloses very small particles of unburned carbon and thus prevents complete combustion. Moreover, these salts when present in considerable quantity show a tendency to cause the tobacco to "coal" or carbonize in advance of the glowing portion, because they decompose so readily when heated.

The fact that the calcium and magnesium salts produce a white ash has already been mentioned, and at least one of these is essential to this property. On the other hand, tobacco containing excessive amounts of lime gives an ash which, although it is very light in color, lacks cohesion, or, in the language of the trade, it "flakes." This is a very objectionable property and must always be taken into account in judging the burning qualities of tobacco. The potash salts, more especially the organic compounds, yield an ash which is firm and compact but dark in color. From these facts, then, it is clear that potash and lime combined in the proper proportion are essential to a firm, light-colored ash. There is no apparent reason to suppose that magnesia is of any special significance in this connection further than the fact that it acts like lime.

THE RELATION OF THE ORGANIC CONSTITUENTS TO THE BURNING QUALITIES.

The organic compounds constitute the material which is consumed in the combustion of the tobacco, and in some way the mineral constituents, more particularly the potash salts, impart to this material the property of burning without flame. If the mineral constituents are extracted from a leaf of tobacco, it will then only burn with a flame, the glowing capacity having been entirely lost. However, some of the organic compounds show a greater tendency to burn with a flame than do others, and hence act less favorably on the glowing capacity, for, as has been stated, these two qualities usually stand in inverse ratio to one another. The principal compounds or classes of compounds which need to be considered in this connection are cellulose, the organic acids, pectin, the so-called tobacco tars, plant wax, the sugars, nicotine, and other organic nitrogenous compounds. For the purpose of studying the composition of the leaf with reference to its burning qualities we may consider cellulose, which constitutes from 10 to 15 per cent of the total weight, as the fundamental or basic material, which receives its capacity for glowing from certain mineral salts. Pure cellulose in the form of filter paper is exceedingly sensitive to the catalytic action of these mineral salts, very small quantities of them being sufficient to cause the paper to burn without flame indefinitely, but when the other organic constituents of tobacco are present this sensibility is greatly affected and much larger quantities of the catalytic agent are necessary to produce a good fire-holding capacity. Cellulose, then, must be considered as a very favorable factor in promoting this property of holding fire.

There are a large number of organic acids normally occurring in tobacco, but of some of these practically nothing is known. Atten-

tion has been called to the fact that citric, malic, oxalic, and acetic acids in combination with potash exert a very favorable influence on the burning qualities. It was found by direct experiment that these acids in the free state injure these qualities, but as they probably never occur free in fermented tobacco this fact is of little consequence. Citric and malic acids are undoubtedly of fundamental importance in producing good burning qualities, but since oxalic acid occurs in combination with lime and not with potash in tobacco it is of little value in this respect. Pectin and the pectoses are present in considerable quantities in cured tobacco leaves, but, according to Schlösing, these are all converted into pectic acid during the process of fermentation. A sample of pectic acid prepared from fermented tobacco was found to produce no injury to the fire-holding capacity; in fact, when combined with potash it acted favorably on this property.

According to Kissling, the tobacco tars, consisting of a mixture of a number of chemical individuals, exert an important influence on the quality of the product. Some of these are of an acid character, while others are indifferent substances. When tobacco is extracted with large volumes of water, as previously described, considerable quantities of these tarry acids combined with nicotine and other bases pass into solution, and on evaporation of the extract the salts are decomposed, the nicotine volatilizing and the tarry acids being precipitated. These acids in the free state were found to be decidedly injurious to the burning qualities, but they occur in tobacco in comparatively small quantities.

A number of samples of tobacco of very poor burning quality were extracted with alcohol to determine if this solvent would remove any constituents deleterious to the burn, but with the exception of a single case this treatment did not improve the tobacco in this respect. The constituents removed by extraction with alcohol are nicotine combined with acids, tannic acid, glucosides, sugars, and the tars and tarry acids; hence it appears that none of these compounds are of special importance with reference to the burn. Direct experiments showed that glucose does not materially influence the burning qualities. Nicotine is the characteristic alkaloid of tobacco and is of great importance with reference to its physiological action, but its salts were found to have no effect on the burn. In addition to nicotine the important nitrogenous constituents are the amido compounds and the albuminoids. It is generally believed that the amido compounds exert a favorable and the albuminoids an unfavorable influence on the desirable qualities of tobacco, including the burn, although there is little experimental proof of this theory. The quantity of plant wax occurring in tobacco is too small to affect the burning qualities.

SUMMARY.

The principal facts brought out by the experiments which have been described on the relation of the chemical composition to the burning qualities of tobacco may be briefly summarized in the following general statements:

(1) The fire-holding capacity is dependent primarily on the content of potash combined with organic acids.

(2) Lime in general does not greatly affect the fire-holding capacity, but is an essential factor in the production of a good ash.

(3) Large amounts of magnesia tend to injure the capacity for holding fire.

(4) Chlorin injures the burning qualities, but it seldom happens that tobacco contains enough of this element to do any serious harm.

(5) Sulphates in general injure the burning qualities, but the effects are not so marked when all the sulphuric acid is combined with potash.

(6) So far as is known none of the organic constituents of tobacco, with the possible exception of the so-called tarry acids and the albuminoids, exert a very important influence on the burning qualities.

From these conclusions it appears that the principal objects to be attained in efforts to improve the burning qualities of tobacco by breeding and by improved methods of production, especially in the use of the proper fertilizers, are (1) a relatively high content of potash combined with citric and malic acids, with a minimum amount of inorganic salts, especially chlorids and sulphates; (2) a moderate content of lime; (3) a comparatively small percentage of magnesia, and (4) a low content of organic nitrogenous compounds, more especially the albuminoids or proteids. Of these problems the first mentioned is altogether the most important from a practical standpoint and also the most difficult to solve. It has long been known that the muriate can not be used as a source of potash in the production of tobacco which is intended for smoking purposes, because of the injurious effects of the chlorin. The other available sources of potash at the present time are the sulphate, the carbonate, and the silicate.

Schlösing,[a] in his experiments with the use of the sulphate as a fertilizer for tobacco, found that the potash is assimilated, while the content of sulphuric acid is not increased. Jenkins,[b] on the other hand, in experiments conducted at the Connecticut Agricultural Experiment Station and extending over a period of several years, has shown that the composition of tobacco ash is profoundly modified by the use of different forms of potash and that applications of

[a] Landw. Vers. Stat., 3, 98.

[b] Ann. Rpt. Conn. Agr. Expt. Sta., 1896.

the sulphate greatly increase the quantity of sulphuric acid in the ash. The carbonate would seem to be an ideal form in which to supply the potash for combining with the organic acids in the plant, and its use has generally been found to improve the burning qualities. But, aside from the high cost of this material, there are other serious objections to its use, for it has a very strong alkaline reaction, and it seems probable that when used in large quantities it will eventually injure seriously the productiveness of the soil. The silicate is free from these objectionable properties, and if the potash can be made available there is every reason to believe that this will prove to be a very valuable source of potash for tobacco.

The sum of the lime and the magnesia in tobacco does not, as a rule, vary widely; or, in other words, the greater the amount of lime the less will be the amount of magnesia, and vice versa. The application of fertilizers containing magnesia increases the percentage of this element in the tobacco, but when used in the form of the carbonate the injury to the burning qualities would be reduced to a minimum. It is believed, however, that the use of fertilizer salts containing magnesia in the form of sulphate is inadvisable.

The percentage of organic nitrogenous compounds, including nicotine, is generally proportional to the luxuriance and vigor of growth; hence tobacco of very rank growth contains excessive quantities of these constituents. Again, these substances are most abundant when the plant is, as a whole, growing most rapidly, and also in the most rapidly growing parts of the plant. Conditions favorable to rank growth are brought about by the use of excessive quantities of nitrogenous fertilizers, especially when the nitrogen is in readily available forms. The chief danger from this source, however, lies in the application of quickly available forms of nitrogen during the later stages of growth, thus preventing or delaying the normal ripening of the leaf. Since the percentage of albuminoids decreases rapidly throughout the ripening process after the leaf has reached its full growth, this is an important reason why tobacco should not be harvested until the leaf is well ripened.

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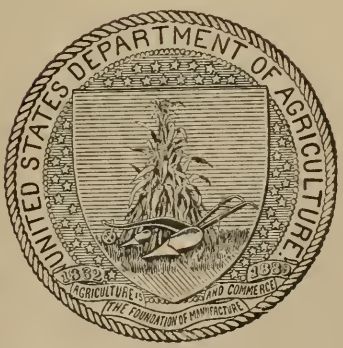
U. S. DEPARTMENT OF AGRICULTURE.
BUREAU OF PLANT INDUSTRY—BULLETIN NO. 106.
B. T. GALLOWAY, *Chief of Bureau.*

SEEDS AND PLANTS IMPORTED

DURING THE PERIOD FROM DECEMBER, 1905, TO JULY, 1906.

INVENTORY No. 12; Nos. 16797 to 19057.

Issued December 20, 1907.



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U. S. DEPARTMENT OF AGRICULTURE.

BUREAU OF PLANT INDUSTRY — BULLETIN NO. 106.

B. T. GALLOWAY, *Chief of Bureau.*

SEEDS AND PLANTS IMPORTED

DURING THE PERIOD FROM DECEMBER, 1905, TO JULY, 1906.

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LETTER OF TRANSMITTAL.

U. S. Department of Agriculture,
Bureau of Plant Industry,
Office of the Chief,
Washington, D. C., April 13, 1907.

Sir: I have the honor to transmit herewith, and to recommend for publication as Bulletin No. 106 of the series of this Bureau, the accompanying manuscript, entitled "Seeds and Plants Imported During the Period from December, 1905, to July, 1906."

This manuscript has been submitted by the Agricultural Explorer in Charge of Seed and Plant Introduction with a view to publication.

Respectfully,

B. T. Galloway,
Chief of Bureau.

Hon. James Wilson,
Secretary of Agriculture.

SEEDS AND PLANTS IMPORTED DURING THE PERIOD FROM DECEMBER, 1905, TO JULY, 1906.

INTRODUCTORY STATEMENT.

This twelfth inventory of seeds and plants imported, prepared under the immediate supervision of Mr. Walter Fischer, represents the accessions of this Office between the dates of December 15, 1905, and July 27, 1906, a period of about seven months. It contains 2,260 items, which is as large a number as was represented by the collections of a whole year when this Office was organized in 1898, notwithstanding the fact that the present lists are the result of a more rigid selection than at the outset.

To the outsider it may seem strange that larger numbers of plants and seeds are not accumulated in so long a period. To these it may be said that it is not the object of the work of plant introduction to collect as many species and varieties of plants which may have some economic use in this country as is possible, but rather to carefully collect only such forms as can be put to a really practical use by American cultivators. This Office is informed of hosts of useful plants now growing in different parts of the world which are not yet on the program of practical plant introduction. At a small expense thousands of these useful plants could be gathered and placed in collections, but the cost of maintaining any one of them would in a few years far exceed the cost of procuring it anew for the definite experiments of the experts of the country who may want it for breeding purposes, as a stock on which to graft, or as a possible new crop for hitherto unused lands.

The principle, then, of systematic plant introduction, as it is carried on by this Office, is to get the seeds and plants that are wanted for the solution of definite problems in the establishment of new plant industries; import them in sufficient quantities for large and conclusive experiments, and place them as soon as possible in the hands of experts who will carry out at once such experiments.

Among the collections of new introductions included in this inventory there are some that are worthy of special mention here. Principal among these are the collections of our agricultural explorer

Mr. Frank N. Meyer, who was sent out to northern China in the summer of 1905 and who has been exploring the remarkable plant regions of the mountains north and west of Peking. His finds, coming as they do from a region with as severe a winter as that of the Middle States, will surely be, we believe, valuable to plant growers over a wide range of territory. In fact, the preliminary trials that have been made with these North Chinese plants in this country show that as a rule they have a degree of hardiness and resistance to disease which their close relatives from Japan, now so abundantly represented in our gardens and fields, do not possess. Mr. Meyer's explorations have been made into different places, difficult and sometimes dangerous of access, and at no little sacrifice of personal comfort and risk to his health and safety. The collections cover a wide range of things for which there is a demand already created by breeding, grafting, and other experiments which have been carried on in this country during the past decade. The material sent in is now in process of propagation, and as soon as ready will be sent out to experimenters.

Other collections worthy of notice are a number of new sorghums from tropical Africa, the home of the sorghum plant; a collection of the interesting new wet-land root crop, the yautia, from Porto Rico; some interesting new forms of potato from Bolivia; leguminous plants for breeding as fodder producers, collected from various parts of the world; forage and fodder grasses in large numbers from many different foreign countries; the Queensland nut Macadamia, which is a possibility for California; the South China soap tree, which has recently come into some prominence in Algeria as a source of saponin, a commercial product used in the manufacture of soaps; a collection of hardy grass and forage plant seed from the Austrian Alpine garden at an altitude of 5,700 feet; three new pistache species for breeding and for stocks on which to graft the ordinary edible variety of this nut, from the borders of Afghanistan, North China, and northern Persia; a collection of West Indian yams, promising possibilities as a change from the monotony of the Irish potato; a number of new Mexican apricots for the fruit-growing areas of Texas and the Gulf States; and a very important collection of the edible-fruited and fodder cacti, made by the cactus expert of the Department, Dr. David Griffiths, who has made experimental plantings of these most interesting plants in the dry regions of the Southwest.

DAVID FAIRCHILD,
Agricultural Explorer in Charge

OFFICE OF SEED AND PLANT INTRODUCTION,
Washington, D. C., April 12, 1907.

INVENTORY.

16797 to 16806.

From Budapest. Presented by Dr. A. de Degen, director of the Royal Hungarian Seed Control. Received December 15, 1905.

Seeds of native Hungarian grasses, as follows:

16797. Bromus vernalis.
16798. Bromus pannonicus.
16799. Avena decora.
16800. Alopecurus brachystachyus.
16801. Festuca carpathica.
16802. Festuca elatior.
16803. Piptatherum virescens.
16804. Glyceria nemoralis.
16805. Poa hybrida.
16806. Poa chaixii.

16807. Oryza sativa. Upland rice.

From Pretoria, Transvaal, South Africa. Presented by Prof. J. Burtt Davy, agrostologist and botanist of the Department of Agriculture. Received December 18, 1905.

"Seed grown in a subtropical valley near Sucre, Bolivia, at an altitude of about 10,000 feet. It is treated as a dry-land crop, like maize." (*Davy.*)

16808. Rubus sp. Red raspberry.

From Baguio, Benguet Province, P. I. Presented by Mr. W. S. Lyon, Bureau of Agriculture, Manila, P. I. Received December 11, 1905.

16809. Panicum molle. Para grass.

From Georgetown, British Guiana. Presented by Mr. A. W. Bartlett, government botanist. Received December 19, 1905.

"A valuable grass for pasture and forage in the Tropics. This grass grows luxuriantly in damp meadows and is readily eaten by horses, cattle, and sheep." (*Bartlett.*)

16810. Xanthosoma sp. Yautia.

From Ancon, Panama. Presented by Mr. George F. Halsey. Received December 19, 1906.

"Tubers of a plant locally called *Oto*, *Coco*, or *Comorata*. It is very hardy and grows best in a well loosened, moist soil, and the tubers can be cut into many sections and planted like potatoes." (*Halsey.*)

16811. Vicia americana. American vetch.

From Fergus Falls, Minn. Presented by Mr. C. J. Wright. Received December 20, 1905.

This is is a native vetch which grows wild in woods and copses in the northeastern United States. It is much relished by stock and might perhaps be cultivated to some extent with profit.

16812. VIGNA UNGUICULATA. **Cowpea.**

From West Branch, Mich. Received through Ogeman Grain and Seed Company, December 20, 1905.

16813 to 16820.

From Office of Drug and Medicinal Plant Investigations. Received through Dr. R. H. True, December 9, 1905.

Seeds of medicinal plants, as follows:

16813. DIGITALIS PURPUREA. **Purple foxglove.**

"The common purple foxglove cultivated in some parts of Europe for its leaves, which are a valuable remedy. The leaves are officinal when picked during the time of flowering. This is one of the most important remedies in certain kinds of heart trouble." (*True.*)

16814. LOBELIA INFLATA. **Indian tobacco.**

"A native weed in open situations of the eastern United States. Both seed and herb collected for drug purposes. Has an emetic, expectorant, and antispasmodic action. Is a strong poison, capable of producing fatal results." (*True.*)

16815. ATROPA BELLADONNA. **Belladonna.**

"Cultivated in several parts of Europe for the leaves and roots, which form one of the chief sources of atropine. The attractive looking fruits also contain atropine and are not rarely eaten by children with fatal results. Is sparingly cultivated in the United States for drug purposes." (*True.*)

16816. NEPETA CATARIA. **Catnip.**

"A common weed of the United States, collected in its wild condition for drug purposes. It is valued as a domestic remedy for its carminative, stimulant, and tonic properties, due to the volatile oil present in the herb." (*True.*)

16817. CAPSICUM FASTIGIATUM. **Japanese chillies.**

"Cultivated in the Orient for the small bright red fruits, having a very pungent taste. Used in medicine for the digestant and rubifacient properties, and also for making the ground cayenne peppers of the spice market." (*True.*)

16818. CAPSICUM FASTIGIATUM. **Small capsicum.**

16819. PAPAVER SOMNIFERUM. **Asiatic poppy.**

"A blue-seeded variety cultivated in the Orient as a source of opium, and in parts of Europe for the seeds, from which an agreeable bland oil is expressed. Seeds from plants grown at Burlington, Vt." (*True.*)

16820. PAPAVER SOMNIFERUM. **Asiatic poppy.**

A white-seeded variety to which the same remarks apply as to the preceding.

16821 to 16852.

From the Office of Farm Management Investigations. Received December 21, 1905.

A collection of grass seeds, as follows:

16821. BROMUS RUBENS.

From Caliente, Kern County, Cal., July 2, 1904. (Agrost. 2132.)

16822. BROMUS sp.

From Arizona, 1904. (Agrost. 2134.)

16823. BROMUS INERMIS. **Smooth brome-grass.**

From Argentina. Peluff's collection, 1904. (Agrost. 2440.)

16824. BROMUS INERMIS. **Smooth brome-grass.**

From Arezzo, Italy, 1904. (Agrost. 2351.)

16821 to 16852—Continued.

16825. BROMUS INERMIS. **Smooth brome-grass.**
From Austria-Hungary. Peluff's collection, 1904. (Agrost. 2449.)

16826. BROMUS PRATENSIS. **Meadow brome-grass.**
From Padua, Italy, 1904. (Agrost. 2373.)

16827. BROMUS UNIOLOIDES. **Rescue grass.**
(Agrost. 2448.)

16828. AGROSTIS STOLONIFERA. **Creeping bent-grass.**
(Agrost. 2323.)

16829. AGROSTIS ALBA. **Redtop.**
(Agrost. 2443.)

16830. AGROSTIS ALBA. **Redtop.**
From Milan, Italy, 1904. (Agrost. 2340.)

16831. AGROSTIS ALBA. **Redtop.**
From Naples, Italy, 1904. (Agrost. 2341.)

16832. AGROSTIS ALBA. **Redtop.**
From Rome, Italy, 1904. (Agrost. 2370.)

16833. PANICULARIA AMERICANA.
From J. M. Thorburn & Co., New York, N. Y.

16834. POA NEMORALIS. **Wood meadow grass.**
From Italy, 1904. (Agrost. 2360.)

16835. POA PRATENSIS. **Kentucky bluegrass.**
From Padua, Italy, 1904. (Agrost. 2350.)

16836. POA PRATENSIS. **Kentucky bluegrass.**
From Treviso, Italy, 1904. (Agrost. 2356.)

16837. LOLIUM PERENNE. **Perennial rye-grass.**
(Agrost. 2319.)

16838. LOLIUM PERENNE. **Perennial rye-grass.**
(Agrost. 2329.)

16839. LOLIUM PERENNE. **Perennial rye-grass.**
(Agrost. 2330.)

16840. LOLIUM PERENNE. **Perennial rye-grass.**
From Turin, Italy, 1904. (Agrost. 2344.)

16841. LOLIUM PERENNE. **Perennial rye-grass.**
From Milan, Italy, 1904. (Agrost. 2362.)

16842. LOLIUM PERENNE. **Perennial rye-grass.**
From Naples, Italy, 1904. (Agrost. 2365.)

16843. LOLIUM PERENNE. **Perennial rye-grass.**
From Florence, Italy, 1904. (Agrost. 2369.)

16844. LOLIUM PERENNE. **Perennial rye-grass.**
From Genoa, Italy, 1904. (Agrost. 2375.)

16845. LOLIUM ITALICUM. **Italian rye-grass.**
From Mantova, Italy, 1904. (Agrost. 2342.)

16846. LOLIUM ITALICUM. **Italian rye-grass.**
From Italy, 1904. Agrost. 2367.)

16821 to 16852—Continued.

16847. LOLIUM ITALICUM. **Italian rye-grass.**

From Conegliano, Italy, 1904. (Agrost. 2371.)

16848. FESTUCA PRATENSIS. **Meadow fescue.**

From Argentina. Peluff's collection, 1904. (Agrost. 2474.)

16849. ALOPECURUS PRATENSIS. **Meadow foxtail.**

(Agrost. 2324.)

16850. DACTYLIS GLOMERATA. **Orchard grass.**

From Padua, Italy, 1904. (Agrost. 2377.)

16851. PHLEUM PRATENSE. **Timothy.**

From Rome, Italy, 1904. (Agrost. 2366.)

16852. HEDYSARUM CORONARIUM. **Sulla.**

From Naples, Italy, 1904. (Agrost. 2397.)

16853. OXALIS ORTGIESI. **Oxalis.**

From Washington, D. C. Received through the National Botanic Garden, December 21, 1905.

16854 to 16861. SORGHUM VULGARE. **Sorghum.**

From Berlin, Germany. Presented by the Berlin Botanical Museum. Received December 20, 1905.

Sorghum varieties from tropical Africa, as follows:

16854. *Orulifer.*
16855. *Usaramensis.*
16856. *Roxburghii.*
16857. *Densissimus.*
16858. *Orulifer.*
16859. *Jucundus.*
16860. *Baumannii.*
16861. *Baumannii.*

16862 to 16865.

From College Park, Md. Received through Mr. H. A. Miller, Agricultural Experiment Station, December 20, 1905.

16862. HORDEUM VULGARE. **Barley.**

Tennessee Winter. (C. I. No. 257.)

16863. AVENA SATIVA. **Oat.**

Sixty-Day. (C. I. No. 165.)

16864. AVENA SATIVA. **Oat.**

Snoma. (C. I. No. 274.)

16865. AVENA SATIVA. **Oat.**

Burt. (C. I. No. 293.)

16866. DIOSCOREA TRIFIDA. **Yampee yam.**

From the Canal Zone. Presented by Mr. George F. Halsey. Received December 27, 1905.

"Roots of a variety apparently distinct from the Jamaica and Porto Rico varieties. This variety should be cultivated in hills and is said to be very productive. The roots are yellowish inside." (*Barrett.*)

16867. SYNCARPIA LAURIFOLIA. **Turpentine tree.**

From Melbourne, Australia. Presented by Prof. W. R. Guilfoyle, director of the Botanic Gardens. Received December 29, 1905.

16867—Continued.

"A tree 100 to 150 feet high with diameter 4 to 5 feet; native of the tropical coast regions of New South Wales and Queensland. Valuable timber tree, especially for posts and underground situations; also for piles, as the resinous matter contained in the wood makes it resistant to damp, the attacks of white ants, and the Teredo. Entirely unprotected piles exposed to the waves for twelve years were found absolutely free from decay and the attacks of the Teredo. The wood is also difficult and slow to burn, a useful property in building lumber. An oleo-resin, in degree and character something between Venice turpentine and Canada balsam, contained in the wood is best collected by felling the tree, when it exudes between the bark and sapwood in small drops, which may be scraped off and the resin collected in a pure state." (*J. H. Maiden.*)

16868. CEROPEGIA FUSCA.

From Grand Canary, Canary Islands. Presented by Mr. Alaricus Delmard. Received December 21, 1905.

16869. CYNARA SCOLYMUS. **Artichoke.**

From Paris, France. Received through Vilmorin-Andrieux & Co., December 29, 1905.

Seed of the *Globe* or *Paris* artichoke.

16870. DIOSPYROS sp. **Sapote negro.**

From Uruapan, Michoacan, Mexico. Presented by Mr. C. G. Pringle. Received December 22, 1905.

16871. PERSEA GRATISSIMA. **Avocado.**

From Miami, Fla. Presented by Mr. S. B. Bliss. Received December 18, 1905.

Trapp.

16872. CITRUS TRIFOLIATA × AURANTIUM. **Citrange.**

From the Plant Breeding Laboratory. Received December 22, 1905.

Trees of the *Morton* citrange, a hybrid between the trifoliate and the sweet orange, developed by Dr. H. J. Webber. (P. B. L. No. 771.)

16873 to 16899.

From Brunswick, Germany. Presented by the Ducal Botanic Gardens. Received December 21, 1905.

A collection of seeds, mostly grass and leguminous forage plants, as follows:

16873. MEDICAGO APICULATA.
16874. MEDICAGO ECHINUS.
16875. MEDICAGO MUREX.
16876. MEDICAGO ORBICULARIS.
16877. MEDICAGO SCUTELLATA.
16878. MEDICAGO TEREBELLUM.
16879. MEDICAGO TRIBULOIDES.
16880. ONOBRYCHIS CHRISTA-GALLI.
16881. ONOBRYCHIS CAPUT-GALLI.
16882. LATHYRUS OCHRUS.
16883. PISUM ELATIUS.
16884. PISUM ARVENSE.
16885. PISUM SATIVUM.
16886. SCORPIURUS SULCATA.
16887. SCORPIURUS MURICATA.
16888. SCORPIURUS VERMICULATA.
16889. SCORPIURUS SUBVILLOSA.
16890. ERODIUM GRUINUM.
16891. ERODIUM MALACHOIDES.
16892. AVENA BREVIS.
16893. AVENA SATIVA DIFFUSA.
16894. AVENA SATIVA DIFFUSA.
16895. AGROPYRON PUNGENS.
16896. BROMUS BRACHYSTACHYS.
16897. BROMUS STERILIS.
16898. HORDEUM AEGICERAS.
16899. HORDEUM ZEOCRITON.

16900. CEPHALARIA TATARICA.

From Stockholm, Sweden. Presented by the Albano Botanic Gardens. Received December 21, 1905.

16901 to 16908.

From Saharanpur, India. Presented by Prof. H. M. Leake, economic botanist, Government Botanic Gardens. Received December 21, 1905.

Grass seeds, as follows:

16901. SYNTHERISMA SANGUINALIS. **Finger grass.**

16902. PANICUM TRYPHERON. **Guinea grass.**

16903. PASPALUM DILATATUM. **Large water grass.**

16904. CHAETOCHLOA GLAUCA. **Yellow foxtail.**

16905. EUCHLAENA MEXICANA. **Teosinte.**

16906. ELEUSINE AEGYPTIACA.

16907. ANDROPOGON PERTUSUS.

16908. ANDROPOGON HALEPENSIS. **Johnson grass.**

16909 to 16927.

From near Peking, China. Received through Mr. Frank N. Meyer, December 26, 1905.

Cuttings of various fruit trees, grapevines, and ornamentals, as follows:

16909. ULMUS sp. **Elm.**

From Nankou. "(No. 31.) A broad-leaved elm suitable for small gardens and parks." (*Meyer.*)

16910. DIOSPYROS KAKI. **Persimmon.**

From Ming Tombs Valley. "(No. 97.) A small, seedless persimmon, with bright, orange-red fruits attaining 2 inches in diameter; later in ripening than the large ones (S. P. I. No. 16912) and not so good. The trees, however, grow to a larger size, and with their leaves dropped off and loaded with orange-colored fruits are very ornamental. Before falling the leaves also assume beautiful colors." (*Meyer.*)

16911. PYRUS SINENSIS. **Pear.**

From Tcha-ching. "(No. 120.) A fine, white pear with melting flesh; is one of China's finest pears. Comes in late, but, being a poor keeper, disappears very early from the markets." (*Meyer.*) (Same as S. P. I. No. 16916.)

16912. DIOSPYROS KAKI. **Persimmon.**

From Ming Tombs Valley. "(No. 104.) A most valuable fruit. The bright, orange-colored fruits attain a diameter of 4½ inches and are perfectly seedless. Bears shipping extremely well if picked when not quite ripe. Can be kept frozen hard if picked too ripe, and if care is taken can be shipped long distances. Finally, their taste is delicious and they would be highly esteemed in America as a table fruit." (*Meyer.*) (See also S. P. I. No. 16921.)

16913. DIOSPYROS KAKI. **Persimmon.**

From Ming Tombs. "(No. 33.) A larger variety of seedless persimmon than is generally seen, but the fact that they grew on a young tree may account for this. It ripens, however, a fortnight later than those sent in under Nos. 16912 and 16921; otherwise the same description applies to it." (*Meyer.*)

16914. CATALPA BUNGEI. **Catalpa.**

From Peking. "(No. 13.) The real *Catalpa bungei*. A fine tree, said to be covered in spring with pink-white flowers; a favorite tree in old temple yards. This one comes from the Yellow Temple, a short distance north of Peking." (*Meyer.*)

16909 to 16927—Continued.

16915. Populus sp. **Poplar.**

From Hwai-jou. "(No. 15.) This poplar seems to be a favorite tree for temple yards; it grows to a very large size, has a straight trunk with branches trimmed high from the ground and with large, dark green leaves. It will be much appreciated as an avenue or park tree." (*Meyer.*)

16916. Pyrus sinensis. **Pear.**

From Tcha-ching. (No. 109.) For description see No. 16911.

16917. Prunus armeniaca. **Apricot.**

From Shan-hai-kwan. "(Nos. 28 and 29.) A wild apricot with small fruits; apparently grows wild in a few cañons." (*Meyer.*)

16918. Prunus sp. **Cherry.**

From Tang-shan. "(No. 93.) Apparently a cherry which grows in bush-like form, much resembling a red currant bush. According to the Chinese, the fruits are small but sweet, ripening in early June." (*Meyer.*)

16919. Amygdalus persica. **Peach.**

From Shan-hai-kwan. "(No. 32.) A wild peach found near an old monastery, but occurring in many different places—probably escaped from cultivation." (*Meyer.*)

16920. Morus alba. **Mulberry.**

From Ming Tombs. "(No. 92.) A form with very deeply cut leaves, which appear to be decidedly different from the common type." (*Meyer.*)

16921. Diospyros kaki. **Persimmon.**

From Ming Tombs Valley. "(Nos. 104 and 105.) These trees are grafted upon wild stock and are planted 20 to 30 feet apart. Being slow growers, peaches are planted between the young trees and afterwards taken out when the persimmons need the space. They seem to love a somewhat sheltered position in the foothills of the mountains in a soil made of decomposed rock." (*Meyer.*)

16922. Fraxinus sp. **Ash.**

From Shan-hai-kwan. "(No. 11.) A decidedly ornamental shade tree; grows in dry situations." (*Meyer.*)

16923. Morus alba. **Mulberry.**

From Ming Tombs. "(No. 91.) Another form with deeply laciniated leaves." (*Meyer.*)

16924. Pyrus sinensis. **Pear.**

From Tcha-ching. "(No. 119.) An attractive, medium-sized white pear with a long stem and nonmelting flesh; much relished by the Chinese." (*Meyer.*)

16925. Populus sp. **Poplar.**

From Kaulitang. "(No. 38.) This poplar thrives in sandy soil and is planted largely on sandy wastes where no other tree would flourish. The Chinese use the wood in building houses, coffins, etc. A rather ornamental tree with silvery bark." (*Meyer.*)

16926. Populus sp. **Poplar.**

From Chang-li. "(No. 30.) A very large poplar with a straight, smooth trunk; well fitted for park or avenue planting." (*Meyer.*)

16927. Vitis sp. **Grape.**

From Hsuen-hwa-fu. "(Nos. 102, 106, and 107.) A fine white grape, berries very long and in heavy bunches; commands high prices and is really a fine table grape; can be kept in paper-lined baskets in a cool place until Chinese New Year (early February)." (*Meyer.*)

16928. VICIA sp. **Vetch.**

From Thomas, Oreg. Presented by Mr. S. W. Gaines. Received December, 1905.

16929 and 16930. QUERCUS spp. **Truffle oaks.**

From Paris, France. Received through Vilmorin-Andrieux & Co., December 30, 1905.

16929. QUERCUS ILEX. **Holly oak.**

16930. QUERCUS PUBESCENS.

Trees introduced for truffle culture.

16931 to 16939.

From St. Louis, Mo. Received through the Missouri Botanical Gardens, January 2, 1906.

A collection of roots, as follows:

16931. MARANTA KEGELJANI.
16932. CALATHEA PRINCEPS.
16933. CALATHEA CROTALIFERA.
16934. CALATHEA sp.
16935. CALATHEA ORNATA SANDERIANA.
16936. CALATHEA OPPENHEIMIANA.
16937. CALATHEA VITTATA.
16938. COLOCASIA NEO-GUINEENSIS.
16939. MARANTA LEUCONEURA KERCHOVIANA.

16940 to 16944.

From Chico, Cal. Grown at the Plant Introduction Garden in 1905. Received December 22, 1905.

Seeds, as follows:

16940. ARACHIS HYPOGAEA. **Peanut.**

Grown from No. 4253.

16941. ARACHIS HYPOGAEA. **Peanut.**

Grown from No. 9406.

16942. VOANDZEIA SUBTERRANEA. **Woandzu.**

Grown from No. 10450.

16943. ARACHIS HYPOGAEA. **Peanut.**

Grown from No. 10622.

16944. ARACHIS HYPOGAEA. **Peanut.**

Grown from No. 11140.

16945 to 16948.

From Victoria, Kamerun, Africa. Received through Mr. H. Nehrling, Gotha, Fla., January 3, 1906.

16945. AMOMUM MELEGUETA. **Paradise seed.**

"Native of tropical western Africa. This plant belongs to the ginger family. From a long, scaly rootstock there are produced leafy branches and short, leafless, flower-bearing branches bearing a single white-purple flower. The fruit is red, large, fleshy, and pear-shaped, containing a large number of brown seeds called paradise seed or Guinea grains. Used only in veterinary medicine and in adulterating liquors and pepper." (*Wheeler.*)

16946. XANTHOSOMA sp. **Yautia.**

"*Xanthosoma violaceum;* cultivated." (*Nehrling.*)

16945 to 16948—Continued.

16947. XANTHOSOMA sp. **Yautia.**

"With light green petioles; cultivated." (*Nehrling.*)

16948. XANTHOSOMA sp. **Yautia.**

"*Colocasia antiquorum;* cultivated." (*Nehrling.*)

16949 to 16979.

From Paris, France. Received through Vilmorin-Andrieux & Co., December 29, 1905.

A collection of seeds, as follows:

16949. ARRHENATHERUM ELATIUS. **Tall oat-grass.**

16950. TRISETUM PRATENSE.

16951. AVENA PUBESCENS. **Downy oat-grass.**

16952. ANTHRISCUS SYLVESTRIS.

16953. BRACHYPODIUM PINNATUM.

16954. BRACHYPODIUM SYLVATICUM.

16955. BROMUS INERMIS. **Smooth brome-grass.**

16956. CORONILLA VARIA. **Crown vetch.**

16957. CYTISUS PROLIFERUS ALBUS. **Broom.**

16958. DACTYLIS GLOMERATA. **Orchard grass.**

16959. FESTUCA DUMETORUM.

16960. FESTUCA ELATIOR. **Tall fescue.**

16961. FESTUCA HETEROPHYLLA. **Various-leafed fescue.**

16962. FESTUCA OVINA. **Sheep's-fescue.**

16963. FESTUCA PRATENSIS. **Meadow fescue.**

16964. FESTUCA RUBRA. **Red fescue.**

16965. FESTUCA TENUIFOLIA. **Slender-leafed fescue.**

16966. HOLCUS MOLLIS. **Creeping soft-grass.**

16967. MELICA CILIATA.

16968. MELICA COERULEA.

16969. MELILOTUS ALBA. **White melilot.**

16970. PASPALUM STOLONIFERUM.

16971. PHALARIS ARUNDINACEA. **Reed canary grass.**

16972. PHLEUM PRATENSE. **Timothy.**

16973. POA COMPRESSA. **Canadian bluegrass.**

16974. POA FERTILIS.

16975. POA SUDETICA.

16976. STIPA TENACISSIMA. **Esparto grass.**

16977. TRIFOLIUM INCARNATUM. **Crimson clover.**

16978. TRIFOLIUM INCARNATUM. **Crimson clover.**
Late.

16979. TRIFOLIUM INCARNATUM. **Crimson clover.**
Extra late; white flowering.

16980 to 16984. ORYZA SATIVA. **Rice.**

From Sivaganga, Madura district, South India. Received through Mr. A. P. Minor, January 4, 1906.

16980.

Jeeragasamba. "(No. 1.) An elegant, very small-sized rice of exceptional whiteness when properly cleaned. It requires an old, well-cultivated soil and will then yield, say, 3,000 pounds per acre or more according to manure applied. The straw is finer and less tough than that of the commoner kinds of paddy and hence is especially valuable as fodder. In good soil it is a 4½ to 5 months' crop." (*Minor.*)

16981.

Varikarudan. (No. 2.)

16982.

Milagi. "(No. 3.) Nos. 2 and 3 give fine white rice, preferred to all others by the higher classes in this part of India. The flavor is supposed to be exceptionally good. Both are hardy and require no exceptional treatment. In an average soil they yield 3,000 pounds per acre and in a well-manured soil up to 5,000 pounds per acre. The straw is good fodder for cattle. The duration of crop is ordinarily 4½ to 5½ months." (*Minor.*)

16983.

Vellakattai, or *Sirumanian.* (No. 4.)

16984.

Erangal, or *Naryan.* "(No. 5.) Nos. 4 and 5 yield a large white rice which is considered particularly nourishing by the lower classes; very hardy, vigorous grower, even in a comparatively poor soil. An ordinary outturn, with little or no manure, is 2,500 pounds per acre, which may be nearly doubled by manuring. The straw is coarser than that obtained from Nos. 2 and 3. The crop matures in 3½ to 4 months, according to soil and other conditions." (*Minor.*)

16985 to 17034.

From Erfurt, Germany. Received through Haage & Schmidt, December 28, 1905.

Seeds of forage crops, as follows:

16985. ASTRAGALUS FALCATUS.
16986. AVENA FLAVESCENS.
16987. BROMUS PRATENSIS.
16988. DACTYLIS GLOMERATA.
16989. FESTUCA ARUNDINACEA.
16990. FESTUCA DURIUSCULA.
16991. FESTUCA ELATIOR.
16992. FESTUCA HETEROPHYLLA.
16993. FESTUCA OVINA.
16994. FESTUCA PRATENSIS.
16995. FESTUCA RUBRA.
16996. FESTUCA TENUIFOLIA.
16997. LUZULA ALBIDA.
16998. LATHYRUS HIRSUTUS.
16999. MELILOTUS COERULEA.
17000. MELILOTUS ALTISSIMA.
17001. MELILOTUS OFFICINALIS.
17002. MELILOTUS PARVIFLORA.
17003. MELILOTUS SEGETALIS.
17004. MELILOTUS SULCATA.
17005. PHALARIS ARUNDINACEA.
17006. PISUM JOMARDI.
17007. PLANTAGO PSYLLIUM.
17008. SPARTIUM SCOPARIUM.
17009. VICIA AGRIGENTINA.
17010. VICIA AMBIGUA.
17011. VICIA BIENNIS.
17012. VICIA CALCARATA.
17013. VICIA CASSUBICA.
17014. VICIA CORDATA.
17015. VICIA CORNIGERA.
17016. VICIA CUSPIDATA.

16985 to 17034—Continued.

17017. Vicia disperma.
17018. Vicia ferruginea.
17019. Vicia gerardi.
17020. Vicia globosa.
17021. Vicia grandiflora.
17022. Vicia hybrida.
17023. Vicia lutea.
17024. Vicia macrocarpa.
17025. Vicia multiflora.
17026. Vicia onobrychioides.
17027. Vicia pannonica.
17028. Vicia peregrina.
17029. Vicia picta.
17030. Vicia pseudo-cracca.
17031. Vicia sylvatica.
17032. Vicia spuria.
17033. Vicia striata.
17034. Vicia tricolor.

17035 to 17050.

From Sydney, New South Wales. Presented by Prof. J. H. Maiden, director of Botanic Gardens. Received January 2, 1906.

17035. Andropogon bombycinus.
17036. Astrebla pectinata.
17037. Astrebla elymoides.
17038. Cenchrus australis.
17039. Chloris truncata.
17040. Chloris ventricosa.
17041. Chrysopogon gryllus.
17042. Panicum decompositum.
17043. Panicum prolutum.
17044. Paspalum brevifolium.
17045. Pennisetum compressum.
17046. Pollinia fulva.
17047. Chaetochloa aurea.
17048. Sporobolus lindleyi.
17049. Stipa elegantissima.
17050. Stipa tuckeri.

17051 and 17052. Bouteloua spp.

From Silver City, N. Mex. Received through Mr. James K. Metcalfe, January 5, 1906.

17051. Bouteloua curtipendula. **Tall grama grass.**
17052. Bouteloua oligostachya. **Blue grama grass.**

17053. Solanum commersoni. **Aquatic potato.**

From Burlington, Vt. Received through Prof. William Stuart, of the Agricultural Experiment Station, January 6, 1906.

Tubers grown from stock obtained through Dr. Edouard Heckel, of Marseille, France. "Heckel is not at all of the opinion that *Solanum commersonii* should replace our common potato; but if it is adapted to swampy locations it would become very valuable to us, and possibly nonbitter hybrids might be produced for poorly drained soils by cross fertilization." (*L. Wittmack, Gartenflora, 54: 452, 1905.*) (See note to No. 10324.)

17054. Solanum commersoni. **Aquatic potato.**

From Santa Rosa, Cal. Received through Mr. Luther Burbank, November 28, 1905, and February 10, 1906.

Tubers grown from No. 10324. "Has rather small vines, produces an enormous amount of flowers all summer and a reasonable amount of seed balls, which, however, unless pollenized from some other variety never produce a seed. Owing to its wandering disposition, not extra quality, and not being very productive it will never become popular. I judge from what I have read in the French papers that the bluish variety is better." (*Burbank.*)

17055 to 17058.

From Buitenzorg, Java. Presented by Doctor Treub, director of the Department of Agriculture. Received January 5, 1906.

17055. ARACHIS HYPOGAEA. **Peanut.**
"Katjang holle."

17056. ARACHIS HYPOGAEA. **Peanut.**
"Katjang banah waspada."

17057. ARACHIS HYPOGAEA. **Peanut.**
"Katjang amerika."

17058. VOANDZEIA SUBTERRANEA. **Woandzu.**
"Katjang bogor."

17059. FESTUCA PRATENSIS. **Meadow fescue.**

From Marysville, Kans. Received through Mr. Frank W. Oakley, January 5, 1906.

17060 and 17061.

From Honolulu, Hawaii. Received through Dr. J. N. Rose, of the United States National Museum, Washington, D. C., December 29, 1905.

Seeds, as follows:

17060. OREODOXA REGIA. **Royal palm.**
(No. 05/876.)

17061. ARISTOLOCHIA sp.
(No. 05/875.)

17062. SOLANUM MELONGENA. **Eggplant.**

From Trebizond, Turkey. Presented by Mr. Vital Ojalvo, vice-consul, through Mr. Frank Benton. Received January 6, 1906.

Seed of a violet-colored variety.

17063 to 17066.

From Moscow, Russia. Presented by Prof. William R. Williams, of the Moscow Agricultural Institute. Received January 8, 1906.

17063. ALOPECURUS RUTHENICUS.
17064. BROMUS MOLLIS.
17065. BROMUS RACEMOSUS.
17066. BROMUS SYLVATICUS.

17067 and 17068.

From Paris, France. Received through Vilmorin-Andrieux & Co., January 9, 1906.

17067. MELILOTUS COERULEA. **Blue sweet clover.**

17068. CORONILLA SCORPIOIDES.

17069 and 17070.

From Dreshertown, Pa. Received through Thomas Meehan & Sons, January 9, 1906.

Stocks upon which to graft imported cuttings, as follows:

17069. MALUS MALUS. **Apple**

17070. PYRUS COMMUNIS. **Pear.**

17071. PANICUM LAEVIFOLIUM.

From Pretoria, Transvaal, South Africa. Presented by Prof. J. Burtt Davy, agrostologist and botanist of the Department of Agriculture. Received January 9, 1906.

17072 to 17075. ELEUSINE CORACANA.

From Bombay Presidency, India. Received through Mr. F. Fletcher, Deputy Director of Agriculture, January 9, 1906.

17072. "*Mukti Nagli.*" (Close heads.) From Lonawla.

17073. "*Zipri Nagli.*" (Open heads.)

17074. "*Nagli.*" (Red.)

17075. "*Nagli.*" (White.)

17076 to 17092.

From Paris, France. Received through Vilmorin-Andrieux & Co., January 9, 1906.

Seeds of forage crops, as follows:

17076.	ANTHYLLIS VULNERARIA.	**Kidney vetch.**
17077.	ASTRAGALUS FALCATUS.	**Milk vetch.**
17078.	BRASSICA OLERACEA.	**Improved branching borecole.**
17079.	BRASSICA OLERACEA.	**Thousand-headed kale.**
17080.	CYTISUS SCOPARIUS.	**Common broom.**
17081.	FESTUCA DUMETORUM.	
17082.	FESTUCA HETEROPHYLLA.	**Various-leafed fescue.**
17083.	FESTUCA OVINA.	**Sheep's-fescue.**
17084.	FESTUCA RUBRA.	**Red fescue.**
17085.	FESTUCA TENUIFOLIA.	**Slender-leaved fescue.**
17086.	LOTUS VILLOSUS.	**Greater bird's-foot trefoil.**
17087.	MEDICAGO MEDIA.	**Sand lucern.**
17088.	POA FERTILIS.	
17089.	POA NEMORALIS.	**Wood meadow grass.**
17090.	POA SEMPERVIRENS.	
17091.	POA TRIVIALIS.	**Rough-stalked meadow grass.**
17092.	ULEX EUROPAEUS.	**Furze, gorse, or whin.**

17093. CHRYSOPHYLLUM CAINITO. **Star-apple.**

From Washington, D. C. Plants grown in the Department greenhouse from seed obtained in 1904 by Mr. G. N. Collins in Jamaica, British West Indies; numbered January 10, 1906.

Fruit from which seeds were obtained was large and light colored.

17094 and 17095. ERAGROSTIS ABYSSINICA. **Teff.**

From Abyssinia. Received through His Excellency S. A. Ras Makomen, January 12, 1906.

17094. Pearl white seed. 17095. Brown seed mixed with white.

"Teff is the staple food of the Abyssinians. Considering the general physique of the nation and that teff is practically the sole means of nourishment, as the poorer classes seldom taste meat, the cereal is undoubtedly rich in nitrog-

17094 and 17095—Continued.

enous matter. It possesses, too, a sufficient quantity of starchy matter to constitute a fairly hygienic diet. Teff is utilized as follows: Ground into flour; made into a semiliquid or thin paste consistency by adding water, and placed in earthen jars. The leaves of the 'Geaho' (gesho) plant, which yield a ferment, are added. When fermentation is complete the sirupy mixture is slowly poured on the surface of well-heated, circular, flat baking pans. After a certain amount of manipulation and turning over, a semiaerated, flat, round cake is the result. This keeps for months without deterioration, is broken into fragments and dried in the sun. The dried bread is used as their chief supply when at war or on expeditions. Teff undoubtedly possesses highly nutritious qualities and is decidedly more digestible than wheat. It could therefore be exploited as an invalid food. Teff is not known to possess distinct drought-resisting properties." (*Extract from letter from the British consul at Adis Ababa, Abyssinia.*)

17096. PHASEOLUS RADIATUS. **Mung bean.**

From Augusta, Ga. Received through the N. L. Willet Seed Company, January 12, 1906.

Newman.

17097 to 17100.

From Channing, Tex. Received through Mr. A. H. Leidigh, January 12, 1906.

17097. TRITICUM DURUM. **Macaroni wheat.**

Galgalos. Grown from No. 9872.

17098. TRITICUM DICOCCUM. **Black emmer.**

Grown from No. 11650.

17099. PANICUM MILIACEUM. **Broom-corn millet.**

Black Voronezh. Grown from No. 9425.

17100. HORDEUM VULGARE. **Barley.**

Tennessee Winter. Grown from No. 11193.

17101 to 17103.

From Sibpur, Calcutta, India. Received through Mr. A. Gage, acting superintendent, Royal Botanic Gardens, January 13, 1906.

A collection of tubers, as follows:

17101. AMORPHOPHALLUS CAMPANULATUS. **Stanley's washtub.**

The members of this genus of aroids are natives of India and other parts of tropical Asia, where they are cultivated for the starch which is so abundant in the rootstock. *Amorphophallus campanulatus* has a tuber weighing 8 to 10 pounds, shaped like a flat cheese; spathe nearly 2 feet broad and 15 inches high, with a horizontal, spreading, fluted border, red-purple on the border, then grayish white spotted and purple in the center. Doctor White says of it that when in flower the fetor it exhales is most overpowering, and so perfectly resembles that of carrion as to induce flies to cover the club of the spadix with their eggs.

17102. COLOCASIA ANTIQUORUM ESCULENTA (?)

(Labeled "*Alocasia antiquorum.*")

17103. ALOCASIA INDICA. **Alocasia.**

"These roots are cultivated to some extent throughout India, but do not occupy so important a place in the domestic economy there as do the taros in Polynesia or the yautias in tropical America." (*Barrett.*)

17104. PHALARIS CANARIENSIS. **Canary grass.**

From Malta. Received through Mr. J. Borg, of the St. Antonio Gardens, January 15, 1905.

Malta canary seed. "Requires the same culture as the late varieties of wheat. Very productive and remunerative, although not much grown in Malta. The grain is slightly larger in size than the best Sicilian canary seed; the plant is also stouter." (*Borg.*)

17105. CINNAMOMUM CAMPHORA. **Camphor.**

From Paris, France. Received through Vilmorin-Andrieux & Co., January 15, 1906.

This plant is the source of camphor, the gum being obtained from the extracted juice. The tree is difficult to transplant and is best propagated by seeds, sown as soon as ripe in a shaded bed, the seedlings being transplanted when very small into pots and kept thus until ready to plant out permanently. The soil best suited to camphor is a sandy loam.

17106 to 17130. AMYGDALUS COMMUNIS. **Almond.**

From Girgenti, Italy. Received through Hon. Francis Ciotta, United States consular agent, January 15, 1906.

Almond cuttings, as follows:

17106.

Cornutella. This is a plant requiring special care, but is highly valued for its sweet and agreeable flavor. The tree will attain a vigorous and strong growth; can be cultivated in all climates.

17107.

Cavaliera. In this the vegetation is especially vigorous, resists frost, yields well, and the fruit is extremely tender, being much sought after as a table fruit.

17108.

Caccia. In this the vegetation is extremely strong, resists the rigors of winter, produces richly, and is incomparable for roasting and for making the finest torroni, the tower-like almond cakes made of almonds and honey.

17109.

Bianca. The tree is of medium development, wood not very solid, yields well, fruit extremely sweet and highly valued for table use.

17110.

Selvaggia. This tree has great resistance, grows in a very luxuriant manner and regular form; bears a tender fruit used by preference for the ordinary torroni, almond cakes of the common quality.

17111.

Carina. This tree is of medium development and is very resistant to frost and inclement weather. It produces abundant small, tender fruit which is excellent for pastry and for the almond paste.

17112.

Regaliana. This tree is of medium size and of ordinary resistance; produces abundantly a fruit valuable for the table, exquisitely sweet and sought for in all the markets for its excellent qualities.

17113.

Inglese. This takes its name from the extensive use to which it is put in the manufacture of special pastes in England. It is very delicate and tender, superior for the table and excellent also for making sweetmeats.

17106 to 17130—Continued.

17114.

Tramontana. Its resistance to frost, which is strong in this almond tree, enables it to grow vigorously in the tramontane regions without injury from exposure to those northern winds. The fruit is sweet and sought after for confectionery.

17115. *Washington.*
17116. *Sicilia.*
17117. *Racalmuto.*
17118. *Signora.*
17119. *Mantia.*
17120. *Gioia.*
17121. *Sanfilippo.*
17122. *Striata.*
17123. *Sanguisuga.*
17124. *Fra Elia.*
17125. *Milocca.*
17126. *Kruger.*
17127. *Gioglio.*
17128. *Nocciola.*
17129. *Rocca Rossa.*
17130. *Giapponese.*

17131. ELYMUS VIRGINICUS SUBMUTICUS. **Wild rye-grass.**

From Union, Oreg. Received through Mr. George Gammie, of the Agricultural Experiment Station, January 13, 1906.

A native of the Rocky Mountains. A coarse, perennial grass, growing on alluvial river banks or in rich low grounds. This grass frequently forms a considerable portion of native meadow lands and makes a coarse hay. It starts growth early in the spring and thus affords a good pasturage.

17132. SOLANUM COMMERSONI. **Aquatic potato.**

From New York, N. Y. Received through J. M. Thorburn & Co., January 15, 1906.

Violet tubers procured direct from Mr. J. Labergerie, and will be compared with the form imported direct from Heckel and the forms received from Luther Burbank. (For description see "Le Solanum Commersonii et ses Variations Pomme de Terre de L'Uruguay (Variete Violette)," by J. Labergerie.)

17133. SECHIUM EDULE. **Chayote.**

From South Island, S. C. Received through Gen. E. P. Alexander, January 12, 1906.

17134. PHASEOLUS RADIATUS. **Mung bean.**

From Chillicothe, Tex. Received through Mr. A. B. Conner, December 23, 1905.

Udid. Grown from No. 8541.

17135 to 17137. ORYZA SATIVA. **Rice.**

From Yokohama, Japan. Received through the Yokohama Nursery Company, January 9, 1906.

Japanese rice grown in Shizuoka Ken district, as follows:

17135. *Tamanishiki.*

17136. *Araki.*

17137. *Mochi.* A glutinous variety mostly used for cakes, candy, etc.

17138 to 17140.

From Manila, P. I. Received through Mr. W. S. Lyon, horticulturist, Bureau of Agriculture, January 16, 1906.

17138. Lilium philippinense. **Benguet lily.**

"Its grassy foliage is striking and graceful. It forces here admirably, and I think should be a good subject for a forcing bulb in cultivation." (*Lyon.*)

17139. Sterculia foetida.

"*Bobug.*" A tall, handsome, smooth tree with whirled horizontal branches, large compound leaves, and large, dull red flowers appearing with the leaves in spreading panicles. The fruit consists of five large follicles, containing 10 to 15 smooth, black seeds the size of filberts, which are roasted and eaten like chestnuts. Native throughout the tropics of the Old World.

17140. Actinorhytis calapparia. **Palm.**

"One of the most attractive palms of the Areceae group that I have ever seen. I think it would prove a useful subject for house decorations, as our native gardeners grow it to a large size (8 to 10 feet) in flat, shallow, 12-inch pans." (*Lyon.*)

17141. Garcinia morella. **Gamboge.**

From Kingston, Jamaica, British West Indies. Received through Dr. W. Fawcett, director of Hope Gardens, January 18, 1906.

Seeds obtained for the purpose of propagating seedling stocks upon which to graft the mangosteen.

17142 and 17143. Passiflora spp.

From Washington, D. C. Plants grown on the grounds of the Department of Agriculture, and numbered for convenience in recording distribution on January 18, 1906.

17142. Passiflora racemosa. **Passion flower.**

17143. Passiflora quadrangularis variegata. **Granadilla.**

17144. Oryza sativa. **Rice.**

From North Galveston, Tex. Received through Dr. S. A. Knapp, January 15, 1906.

Egyptian. "The *Egyptian* rice is locally known in Louisiana as *Bull* rice and has been grown there for a great many years. It has a large berry of the Japanese type—that is, thick and short kernel—somewhat larger than the *Kiushi* rice, dark colored and much softer when it first ripens, so that it answers excellently for the purpose of stock food. It also has more protein than the ordinary rice. The characteristics of its growth are that it requires very little water, has a strong stalk, abundant leaf, is a heavy producer, and will generally make a crop even though the other rices fail. For these reasons it is grown in Louisiana as a stock food." (*Knapp.*)

17145. Diospyros virginiana. **Persimmon.**

From Augusta, Ga. Received through the P. J. Berckmans Company, January 19, 1906.

Seedling stocks for use in grafting imported scions.

17146. Garcinia mangostana. **Mangosteen.**

From Buitenzorg, Java. Received through Dr. M. Treub, director of the Botanical Gardens, January 19, 1906.

17147. HORDEUM DISTICHUM NUTANS. **Barley.**

From Fort Atkinson, Wis. Received through Mr. W. D. Hoard, January 17, 1906.

Hanna.

17148. AVENA SATIVA. **Oat.**

From Brandon, Wis. Received through Mr. David Jones, January 20, 1906.

Kherson.

17149. XANTHOSOMA sp. **Yautia.**

From Linares, Nueva Leon, Mexico. Presented by Dr. F. Franceschi, Santa Barbara, Cal. Received January 22, 1906.

Linares.

17150. REHMANNIA ANGULATA.

From Narberth, Pa. Received through Mr. William Tricker, January 19, 1906.

"Introduced by James Veitch & Son, London, England. A native of central China; has proved hardy on the Cotswold Hills, England, 750 feet above sea level, without protection; and with moderate protection withstood the severe winter of 1904–5 in Massachusetts. Awarded certificate of merit at Royal Horticultural Society in 1903. Seedlings raised in the spring of 1905, which were planted out under similar conditions with other herbaceous plants, made rapid progress and some commenced to flower in July and were still in flower October 19. Others probably will not flower until 1906, exhibiting more the character of biennials. The plants are vigorous, leaves radical laciniate, of a deep green color and 12 to 15 inches long. Some plants sent up one spike from the main crown, while others sent up several spikes but weaker. Main spikes have produced lateral growths with flowers. Several spikes were 4 feet tall. Flowers like *Bignonia grandiflora* (except in color) are produced at the axils of the leaves. Size, 3 inches in diameter, color, rose-purple with a rich yellow throat spotted with purple. The individual flower resembles *Incarvillea delavayi*. Plants thrive in ordinary garden soil; should have full sunshine and ample space between plants—about 2 feet. Flowers are good for cutting, remaining several days in good condition." (*Tricker.*)

17151. CITRUS AURANTIUM. **Orange.**

From Siang-tan, Hunan Province, China. Received from Mr. S. A. McCalla, through Prof. H. A. Morgan, director of the Agricultural Experiment Station, Knoxville, Tenn., January 17, 1906.

Orange seeds said by Doctor Webber to be of a tangerine type.

"The oranges grown hereabouts are of both the loose-skinned and the tight-skinned varieties. None of them are especially good. The town of Li-ling, which has a latitude of 27° 42′ N., is the northern limit of the tight-skinned oranges, but the loose-skinned variety grows as far north as Chang-sha, which is probably about 400 feet above sea level. Nearly every winter there are one or two big snows. I have seen two in the last five years about 9 inches deep; also, from time to time there are freezes, but the orange trees never seem to suffer." (*McCalla.*)

17152 to 17162.

From Chi-li Province, China. Received through Mr. Frank N. Meyer, December, 1905.

Cuttings of fruits and vines, as follows:

17152. PRUNUS ARMENIACA. **Apricot.**

From Tchu-chung. "(No. 118.) This is one of the finest white apricots that grows in China, as I have been told by the natives. They describe the fruit as being very large and white skinned, with a few red spots." (*Meyer.*)

17152 to 17162—Continued.

17153. PRUNUS ARMENIACA. **Apricot.**

From Tcha-ching. "(No. 113.) The kernels of this apricot are sold as almonds; they are small but taste fine. The trees grow very bushy and are grafted upon wild stock." (*Meyer.*)

17154. PRUNUS ARMENIACA. **Apricot.**

From Tcha-ching. "(No. 112.) A large, red apricot described by the natives as being very good." (*Meyer.*)

17155. VITIS VINIFERA. **Grape.**

From Chang-li. "(No. 114.) This is a very fine white grape belonging to the *Muscat* group. In North China it commands more than three times as much money as is paid for the purple grape." (*Meyer.*)

17156. VITIS VINIFERA. **Grape.**

From Hsuen-hwa-fu. "(No. 101.) A splendid green-white grape, considered as the best grape here in China. The berry is very long and the bunches are rather large. The taste is fresh sweet, without being too sweet. An excellent table grape. It is apparently a kind of *Muscat* grape, not being free skinned and having the same general appearance." (*Meyer.*)

17157. VITIS sp. **Grape.**

From Chang-li. "(No. 115.) A dark purple grape; a very heavy bearer. The taste is a trifle watery, but otherwise it is all right. Is a very late grape, the last which appears here on the markets. Free skin; produces very large bunches." (*Meyer.*)

17158. VITIS sp. **Grape.**

From Hsuen-hwa-fu. "(No. 103.) A small purple grape from this region, where it gets intensely cold; the vines are buried over winter." (*Meyer.*)

17159. VITIS sp. **Grape.**

From Hwai-jou. "(No. 95.) A purple grape, said to be early and of good quality." (*Meyer.*)

17160. VITIS sp. **Grape.**

From Hwai-jou. "(No. 94.) A white grape growing near Hwai-jou. I was not able to see any fruit, but am told that it is an early, sweet grape." (*Meyer.*)

17161. VITIS sp. **Grape.**

From Chang-li. "(No. 116.) A light purple colored grape; heavy bearer; large bunches; free skin. Tastes somewhat watery. Might do fine as a wine producer. Is well esteemed here on account of coming the last in season." (*Meyer.*)

17162. (Undetermined.)

From Hwai-jou "(No. 110.) Cuttings of a vine used around here for tying grapes to the trellises. Looks like Aristolochia. Is not produced here, but comes from farther south. It is very tenacious material, admirably fit for the the purpose." (*Meyer.*)

17163 to 17166.

From Queretaro, Mexico. Received through Señor Carlos J. Urquiza, January 20, 1906.

17163. MEDICAGO SATIVA. **Alfalfa.**

17164. VICIA FABA. **Broad bean.**

17165. LENS ESCULENTA. **Lentil.**

17166. (Undetermined.)

Shotolillo.

17167 to 17181.

From Chi-li Province, China. Received through Mr. Frank N. Meyer, January 24, 1906.

A collection of cuttings, as follows:

17167. AMYGDALUS PERSICA. **Peach.**

From Tung-chow. "(No. 35.) A large, white peach, considered a fine fruit by the Chinese. Nonmelting flesh. The tree is a very thrifty grower." (*Meyer.*)

17168. CELTIS sp. **Hackberry.**

From Shan-hai-kwan. "(No. 3.) An oramental shade tree, growing in dry, rocky situations; if not too heavily attacked by gall insects is decidedly ornamental." (*Meyer.*)

17169. CORYLUS sp. **Hazelnut.**

From Shan-hai-kwan. "(No. 7.) A low shrub found on steep, rocky mountain sides. May do well as undershrub beneath tall trees." (*Meyer.*)

17170. CRATAEGUS sp. **Hawthorn.**

From Chang-li. "(No. 10.) A small-leaved Crataegus growing wild in the mountains around here. It is used as stock for *Crataegus pinnatifida*." (*Meyer.*)

17171. CRATAEGUS PINNATIFIDA. **Hawthorn.**

From Chang-li. "(No. 9.) A very large-fruited variety of which seeds were sent to Washington under No. 57a. A remarkable ornamental tree. Is a slow grower, but has large, glossy, dark green leaves, and is loaded in fall with scarlet fruits. In China itself there is not enough of this fruit to supply the demand for making preserves." (*Meyer.*)

17172. DIOSPYROS KAKI. **Persimmon.**

From Chang-li. "(No. 4.) A medium sized, seedless persimmon. Seems to be a variety of *Diospyros kaki*. Fruit globular, 2 inches in diameter, orange color. The trees grow 30 to 40 feet high." (*Meyer.*)

17173. DIOSPYROS LOTUS. **Persimmon.**

From Chang-li. "(No. 50.) A wild persimmon on which the large seedless varieties are grafted; is itself also an ornamental tree." (*Meyer.*)

17174. POPULUS sp. **Poplar.**

From Shan-hai-kwan. "(No. 14.) A very white barked poplar which is extremely cheery in winter landscape on account of its shining white bark. Grows to a rather large-sized tree, 60 to 80 feet. Well fit for an avenue tree or to be planted in groups in parks." (*Meyer.*)

17175. POPULUS sp. **Poplar.**

From Shan-hai-kwan. "(No. 40.) A very white barked poplar, growing close to the seashore near Shan-hai-kwan. Probably the same as No. 14 (S. P. I. No. 17174), but its locality close to the sea made it look different." (*Meyer.*)

17176. PYRUS sp. **Pear.**

From Chang-li. "(No. 36.) A very small pear. The fruits do not grow larger than a small cherry. Fit perhaps as an ornamental tree." (*Meyer.*)

17177. PYRUS sp. **Pear.**

From Shan-hai-kwan. "(No. 37.) A wild pear growing in a rocky ravine." (*Meyer.*)

17178. PYRUS SINENSIS. **Pear.**

From Chang-li. "(No. 39.) A large yellow pear, nonmelting flesh. Can be kept for many months without spoiling. May be of use in crossing with better kinds." (*Meyer.*)

17167 to 17181—Continued.

17179. SALIX sp. **Willow.**

From Shan-hai-kwan. "(No. 49.) A willow which is used to make strong baskets from. The bark of an older tree becomes pitch black and looks as such rather curious." (*Meyer.*)

17180. (Undetermined.)

From Shan-hai-kwan. "(No. 5.) A plant with long, fierce spines, which might make it suitable for a hedge plant; grows to be a good-sized tree." (*Meyer.*)

17181. XANTHOXYLUM sp. **Prickly ash.**

From Shan-hai-kwan. "(No. 12.) Probably not possible to grow from cuttings. Seeds sent to Washington, D. C., under No. 125a." (*Meyer.*)

17182 to 17234.

From Richmond, New South Wales. Received through Mr. H. W. Potts, principal of the Hawkesbury Agricultural College, January 20, 1906.

Grass seeds, as follows:

17182. ANDROPOGON sp. **Bluestem.**

17183. ANDROPOGON AFFINIS. **Coast bluestem.**

17184. ANDROPOGON SERICEUS. **Hairy bluestem.**

17185. ASTREBLA ELYMOIDES. **Coarse Mitchell grass.**

17186. ASTREBLA ELYMOIDES. **Coarse Mitchell grass.**

17187. ASTREBLA PECTINATA. **Mitchell grass.**

17188. ASTREBLA PECTINATA. **Mitchell grass.**

17189. ASTREBLA TRITICOIDES. **Mitchell grass.**

17190. ASTREBLA TRITICOIDES. **Mitchell grass.**

17191. CHLORIS ACICULARIS. **Star grass.**

17192. CHLORIS VENTRICOSA. **Windmill grass.**

17193. CHLORIS TRUNCATA. **Umbrella grass.**

17194. CHLORIS TRUNCATA. **Umbrella grass.**

17195. CHRYSOPOGON GRYLLUS.

17196. DEYEUXIA FORSTERI. **Bent-grass.**

17197. DANTHONIA CARPHOIDES. **Oat-grass.**

17198. DANTHONIA CARPHOIDES. **Oat-grass.**

17199. DANTHONIA NERVOSA. **Swamp wallaby.**

17200. DANTHONIA NERVOSA. **Swamp wallaby.**

17201. DANTHONIA PENICILLATA. **Wallaby grass.**

17202. DANTHONIA PENICILLATA. **Wallaby grass.**

Broad-leaved form.

17203. DANTHONIA SEMIANNULARIS. **Wallaby grass.**

17204. DANTHONIA PENICILLATA var.

A broad-leaved variety.

17205. DANTHONIA PENICILLATA var.

17206. DANTHONIA PENICILLATA var.

17207. DANTHONIA PENICILLATA.

17182 to 17234—Continued.

17208. Danthonia penicillata villosa.

17209. Danthonia penicillata.

17210. Danthonia penicillata.

17211. Danthonia semiannularis. **Wallaby grass.**

17212. Diplachne fusca. **Brown-flowered swamp-grass.**

17213. Diplachne fusca **Brown-flowered swamp-grass.**

17214. Diplachne peacockii.

17215. Eleusine aegyptiaca. **Crowfoot.**

17216. Eragrostis sp. (Probably *E. leptostachya.*)

17217. Eragrostis brownei. **Love-grass.**

17218. Eragrostis leptostachya. **Love-grass.**

17219. Eragrostis pilosa. **Weeping love-grass.**

17220. Eriochloa polystachya. **Early spring-grass.**

17221. Neurachne mitchelliana. **Mulga grass.**

17222. Panicum arachyrachus.

17223. Panicum decompositum. **Australian millet.**

17224. Panicum flavidum. **Vandyke grass.**

17225. Panicum flavidum. **Vandyke grass.**

17226. Panicum leucophaeum. **Cotton grass.**

17227. Panicum prolutum.

17228. Panicum prolutum

17229. Poa caespitosa. **Tussock poa.**

17230. Pollinia fulva. **Sugar grass.**

17231. Pappophorum commune. **Pappus grass.**

17232. Pappophorum commune. **Pappus grass.**

17233. Chaetochloa aurea. **Yellow foxtail.**

17234. Diplachne dubia. **Cane-grass.**

17235. Aralia cordata. **Udo.**

From Yokohama, Japan. Received through the Yokohama Nursery Company, January 26, 1906.

Kan udo.

17236 to 17244.

From Buitenzorg, Java. Received through Dr. M. Treub, director of the Department of Agriculture, January 26, 1906.

17236. Alocasia macrorhiza.

Malay name "Senteh."

17237 to **17244.** Colocasia antiquorum. **Taro.**

17237. Variety *nigra.* Malay name "Kiempoel ietem."

17238. Variety *monorhiza atroviridis.* Malay name "Talus romah."

17239. Variety *monorhiza scripta.* Malay name "Talus soerat."

17240. Variety *monorhiza nigra.* Malay name "Talus lampoeng ietem."

17241. Variety *monorhiza nigra.* Malay name "Talus lahoen indoeng."

17236 to 17244—Continued.

17242. Variety *monorhiza bayabon*. Malay name "Talus pandan."

17243. Variety *monorhiza bayabon*. Malay name "Talus ketan."

17244. Variety *monorhiza bayabon*. Malay name "Talus kiara."

17245. ERODIUM CYGNORUM. **Stork's-bill or crow's-foot.**

From Sydney, New South Wales. Presented by the director of the Botanic Gardens through Mr. Walter S. Campbell, director of Agriculture. Received January 22, 1906.

"An annual or biennial herb with procumbent or slightly erect stems extending from 1 foot to 3 feet or more in length. This plant is widely distributed throughout the Australian continent, being found in the interior of all the colonies, and in some situations it is moderately plentiful. Its free-seeding qualities have rendered it somewhat proof against extermination. During the spring and early summer months this plant affords a rich succulent herbage, which herbivora of all descriptions are remarkably fond of. Horses will often leave good herbage to browse upon it. Pastoralists speak very highly of this plant as affording good herbage while it is in a young state. But when it is ripening its seeds it is somewhat dreaded by the sheep owner on account of the sharp pointed seed lobes, which not only attach themselves firmly to the wool but the barbed points often penetrate the skin of the animal. Notwithstanding this, however, the plant has much to recommend it as a pasture herb, for it will grow well on the poorest of soils. Many of the dry sandhills of the interior would have little vegetation on them during the early summer months if it were not for this plant. Under cultivation it produces a great amount of herbage, and if cut when it shows its flowers it is not only valuable as a green feed, but it can be made into capital hay. Taking into consideration its great productiveness, we think it might be turned into ensilage with good results. *E. cygnorum* is the only species of the genus that is endemic in Australia." (*Flora Austr., 1:297.*)

17246 and 17247. NICOTIANA SANDERAE.

From St. Albans, England. Received from Sander & Sons through J. M. Thorburn & Co., New York, N. Y., January 18, 1906.

17246. NICOTIANA SANDERAE. **17247.** NICOTIANA SANDERAE hyb.

17248 and 17249.

From Salisbury, Rhodesia, South Africa. Presented by Hon. E. Ross Townsend, Secretary for Agriculture. Received January 29, 1906.

17248. CHLORIS VIRGATA. **Rhodes-grass.**

"Regarded as a very valuable forage plant." (*Townsend.*) (See No. 9608.)

17249. PANICUM sp. **White rapoka.**

"The *rapoka* is a millet which forms the staple article of diet among Mashona natives, and the grass is considered to be excellent for making hay or ensilage. This sample is supposed to be a new and better variety recently introduced from north of the Zambesi." (*Townsend.*)

17250. PISTACIA VERA. **Pistache.**

From Saratoga, Cal. Presented by Rev. A. Fuller. Received January 29, 1906.

Large Red Aleppo.

17251 to 17280. GLYCINE HISPIDA. **Soy bean.**

From Arlington Farm, Virginia.

A collection of soy beans grown on the Arlington Farm in 1905 from seed received through the Division of Agrostology.

Black varieties:

17251. Medium early, black. Grown from Agrost. Nos. 1978, 1979, and 2033, combined.

17251 to 17280—Continued.

Black varieties—Continued.

17252. Flat, medium large, late, black; third crop from Agrost. No. 1293.

17253. Medium black; second crop from Agrost. No. 1536.

17254. Medium black, small seeded; first crop from Agrost. No. 1980.

17255. Medium black, medium early; second crop from Agrost. No. 1188.

Brown varieties:

17256. Medium, reddish brown; second crop from Agrost. No. 1542.

17257. *Brown Eda Mame*, medium early; second crop from Agrost. No. 1185.

17258. *Ogemaw*, early; first crop from Agrost. No. 1992 or S. P. I. No. 13502.

17259. Brown, early; first crop from Agrost. No. 2031.

Green varieties:

17260. *Green Samarow*, medium, medium early; first crop from Agrost. No. 1972.

17261. Large, medium, green; fourth crop from Agrost. No. 912 or S. P. I. No. 13503, first crop from Agrost. Nos. 1764 and 1971, combined.

Greenish-yellow varieties:

17262. Small, early, greenish yellow; third crop from Agrost. No. 1297.

17263. Small, medium late, greenish yellow; second crop from Agrost. No. 1539.

17264. Medium late, greenish yellow; second crop from Agrost. No. 1198.

17265. Medium late, greenish yellow; second crop from Agrost. No. 1200.

17266. Large, medium late, greenish yellow; second crop from Agrost No. 1171 or S. P. I. No. 9409.

17267. Late, large, greenish yellow; third crop from Agrost. No. 1298.

Yellow varieties:

17268. *Ito San*, medium, early, yellow; first crop from Agrost. Nos. 1973, 1974, 1975, and 1765, combined.

17269. Dwarf, early, yellow; third crop from Agrost. No. 976.

17270. Medium yellow, small seed; fourth crop from S. P. I. No. 4912, third crop from Agrost. No. 1169 or S. P. I. No. 9407, and first crop from S. P. I. No. 12399.

17271. Medium early, yellow; second crop from Agrost. No. 1194.

17272. Small, medium yellow; second crop from Agrost. No. 1538.

17273. Medium early, yellow; second crop from Agrost. No. 1197.

17274. Small, early, yellow; second crop from Agrost. No. 1199.

17275. Medium yellow, large seed; third crop from Agrost. No. 1170 or S. P. I. No. 9408, first crop from Agrost. No. 1170–2 or S. P. I. No. 12400, and third crop from Agrost. No. 1296.

17276. Medium early, yellow from Thackara; second and third crops from Agrost. No. 1299.

17277. Medium early, yellow; third crop from Agrost. No. 1295.

17278. Large, medium late, yellow; first crop from Agrost. No. 2032.

17279. Large, late, yellow; first crop from Agrost. No. 2034.

17280. Large, late, yellow; first crop from Agrost. Nos. 1976 and 1977.

17281. MEDICAGO SATIVA. **Alfalfa.**

From Deseret, Utah. Received through Mr. Frank Hinckley, January 31, 1906.

Turkestan. Grown from S. P. I. No. 991.

17282. SECHIUM EDULE. **Chayote.**

From New Orleans, La. Presented by Mr. Aristide Hopkins. Received January 31, 1906.

"Fruit of a white variety considered more delicate than the green variety." (*Hopkins.*)

17283 to 17326. PHASEOLUS spp. **Bean.**

From Arlington Farm, Virginia.

A collection of beans grown on the Arlington Farm in 1905 from S. P. I. seed.

PHASEOLUS RADIATUS. **Mung bean.**

17283. Very early. Grown from No. 1161.

17284. Very early. Grown from No. 8814.

17285. Very early. Grown from No. 9889.

17286. Larger than No. 17283. Grown from No. 6430.

PHASEOLUS sp.

17287.

PHASEOLUS RADIATUS. **Mung bean.**

17288. Larger than No. 17283. Grown from No. 10407.

17289. Medium early, medium size. Grown from No. 13394.

17290. Medium early, medium size. Grown from No. 13397.

17291. Medium early, medium size. Grown from No. 13398.

17292. Early, medium size. Grown from No. 13396.

17293. Medium early, medium large. Grown from No. 10610.

17294. Medium early, medium large. Grown from No. 9786.

17295. Early, medium large. Grown from No. 8540.

17296. Early, large. Grown from No. 8486.

17297. Smaller than others. Grown from No. 5071.

17298. Earlier and larger, but otherwise similar to No. 17297. Grown from No. 5437.

17299. Late, medium size. Grown from No. 10527.

17300. Late, large. Grown from No. 12775.

17301. Late, large. Grown from No. 13395.

17302. Medium late, large. Grown from No. 6562.

17303. Medium late. Grown from No. 6378.

17304. Late, large. Grown from No. 1385.

PHASEOLUS MAX. **Mung bean.**

17305. Medium early, small. Grown from No. 8541.

17306. Medium, poor. Grown from No. 13400.

17307. Medium, poor. Grown from No. 13401.

17308. Trailing. Grown from No. 13402.

17309. Trailing. Grown from No. 13403.

17283 to 17326—Continued.

PHASEOLUS CALCARATUS.

17310. Late, large. Grown from No. 6564.

17311. Late, medium large. Grown from No. 13380.

17312. Late, medium large. Grown from No. 13383.

17313. Late, medium size. Grown from No. 13381.

17314. Late, medium size. Grown from No. 13382.

PHASEOLUS ANGULARIS. **Adzuki bean.**

17315. Very early, small. Grown from No. 10523.

17316. Large, similar to No. 17315. Grown from No. 8488.

PHASEOLUS sp.

17317. Earlier and larger than the average. Grown from No. 13393.

17318. Medium size, medium early. Grown from No. 13392.

PHASEOLUS ANGULARIS. **Adzuki bean.**

17319. Medium size, medium early. Grown from No. 13391.

17320. Late, large. Grown from No. 13405.

17321. Late, large. Grown from No. 13386.

17322. Late, large. Grown from No. 13384.

17323. Late, medium large. Grown from No. 6417.

PHASEOLUS sp.

17324. Earlier than No. 17323, small. Grown from No. 6418.

PHASEOLUS ANGULARIS. **Adzuki bean.**

17325. Late, medium large. Grown from No. 8487.

PHASEOLUS RADIATUS. **Mung bean.**

17326. Smaller than the average, quite late; not promising. Grown from No. 3868.

17327 to 17436. VIGNA UNGUICULATA. **Cowpea.**

From Arlington Farm, Virginia. Crop of 1905.

17327. Black and white mottled.

17328. *Chinese Red.* Grown from Agrost. No. 979–3.

17329. *Chinese Browneye.* Grown from Agrost. No. 980–3.

17330. *Chinese Whippoorwill.* Grown from Agrost. No. 985–3.

17331. *Downs Early Ripener.* Grown from Agrost. No. 1090–2.

17332. Grown from S. P. I. No. 8354.

17333. Grown from S. P. I. No. 6431.

17334. Grown from Agrost. No. 1204–1a–1a.

17335. *Extra Early Blackeye.* Grown from Agrost. No. 1232–3 or S. P. I. No. 13456.

17336. *Early Black.* Grown from Agrost. No. 1233–1c–1b.

17337. *Early Black.* Grown from Agrost. No. 1233–1a–1a.

17338. *California Blackeye.* Grown from Agrost. No. 1231–3 or S. P. I. No. 13457.

17339. *Southdown Mottled.* Grown from Agrost. No. 1221–3.

17340. *Clay.* Grown from Agrost. No. 1255–3 or S. P. I. No. 13458.

17327 to 17436—Continued.

17341. *Browneye.* Grown from Agrost. No. 1208–3.

17342. *Taylor.* Grown from Agrost. No. 1248–3 or S. P. I. No. 13476.

17343. *Early Black.* Grown from Agrost. No. 1233–3.

17344. *Unknown.* Grown from Agrost. No. 1251–3 or S. P. I. No. 13468.

17345. *Warren's New Hybrid.* Grown from Agrost. No. 1288–3 or S. P. I. No. 13471.

17346. *Large Blackeye.* Grown from Agrost. No. 1224–3 or S. P. I. No. 13455.

17347. Grown from Agrost. No. 1204–1d–1b.

17348. *Browneye Crowder.* Grown from Agrost. No. 1209–2.

17349. *Whippoorwill.* Grown from Agrost. No. 1269–2 or S. P. I. No. 13475.

17350. *Red Ripper.* Grown from Agrost. No. 1275–3.

17351. *Clay.* Grown from Agrost. No. 1255–1a–1a.

17352. *Warren's Extra Early.* Grown from Agrost. No. 1218–3.

17353. *Unknown.* Grown from Agrost. No. 1251–1a–1a.

17354. *Old Man.* Grown from Agrost. No. 1219–3.

17355. *Large Blackeye.* Grown from Agrost. No. 1224–1c–1.

17356. *Unknown.* Grown from Agrost. No. 1251–1a–1b.

17357. Grown from Agrost. No. 1261–1c–1b.

17358. *Clay.* Grown from Agrost. No. 1255–1c–1a.

17359. *Lady,* broad whitish. Grown from Agrost. No. 1246–1b–1.

17360. Grown from Agrost. No. 1261–1a–1a.

17361. *Red Ripper.* Grown from Agrost. No. 1257–3.

17362. *Large Blackeye.* Grown from Agrost. No. 1224–1a–1a.

17363. *White Crowder* × *Whippoorwill.* Grown from Agrost. No. 1216–2.

17364. *Taylor.* Grown from Agrost. No. 1248–1a–1a.

17365. *Red Yellow-Hull.* Grown from Agrost. No. 1278–3.

17366. *Blackeye* (white giant). Grown from Agrost. No. 1210–3.

17367. *Iron.* Grown from Agrost. No. 1247–3.

17368. *Taylor.* Grown from Agrost. No. 1248–1c–1b.

17369. *Red Maure* selection. Grown from Agrost. No. 1479–1a–1.

17370. *Brown Crowder.* Grown from Agrost. No. 1490–2.

17371. *Small Whippoorwill Crowder.* Grown from Agrost. No. 1490½–2.

17372. *Wight Black Crowder.* Grown from Agrost. No. 1496–2.

17373. *Delicious Large Lady.* Grown from Agrost. No. 1486–2.

17374. *Red Whippoorwill.* Grown from Agrost. No. 1596–1.

17375. *Jhunga,* large white. Grown from Agrost. No. 1620–1G.

17376. *Chauli,* white. Grown from Agrost. No. 1632–1.

17377. *Choli,* small red. Grown from Agrost. No. 1636–1G.

17378. *Bhadela,* red. Grown from Agrost. No. 1629–1.

17379. *Bhadela,* red. Grown from Agrost. No. 1629–1G.

17380. *Barbati,* large red. Grown from Agrost. No. 1625–1G.

17381. *Choli,* small red. Grown from Agrost. No. 1636–1.

17327 to 17436—Continued.

17382. *Barbati*, large red. Grown from Agrost. No. 1625–1.

17383. *Clay*, from *Melear*. Grown from Agrost. No. 17778–1.

17384. Selection from hybrid *Black* × *Iron*. Grown from Agrost. No. 2638.

17385. Selection from hybrid *Black* × *Iron*. Grown from Agrost. No. 2637.

17386. *Sixty-Day*. Grown from Agrost. No. 2649.

17387. *Sixty-Day*. Grown from Agrost. No. 2651.

17388. *Lady-Finger*. Grown from Agrost. No. 2630.

17389. Selection from hybrid *Black* × *Iron*. Grown from Agrost. No. 2639.

17390. *Grayeye*. Grown from Agrost. No. 2631.

17391. Selection from *Clay*. Grown from Agrost. No. 2634.

17392. *Powell's Early Prolific*. Grown from Agrost. No. 2643.

17393. *Red Crowder*. Grown from Agrost. No. 2642.

17394. *Yellow Sugar Crowder*. Grown from Agrost. No. 2645.

17395. Selection from *Clay*. Grown from Agrost. No. 2633.

17396. Selection from *Iron*. Grown from Agrost. No. 2636.

17397. Selection from *Iron*. Grown from Agrost. No. 2635.

17398. *Browneye Crowder*. Grown from Agrost. No. 2641.

17399. *Whittle*. Grown from Agrost. No. 2644.

17400. Selection from second hybrid *Brown* × *Iron*. Grown from Agrost. No. 2640.

17401. *Rice, Long Lady*. Grown from Agrost. No. 1954–1.

17402. *Michigan Favorite*. Grown from Agrost. No. 1991–1.

17403. *New Era*. Grown from Agrost. No. 1936–1.

17404. *Brown Coffee*. Grown from Agrost. No. 1985–1G.

17405. Pinkish tan selection from *Steckler's Improved*. Grown from Agrost. No. 1935–c.

17406. *Michigan Favorite*. Grown from Agrost. No. 1991.

17407. *Steckler's Improved*. Grown from Agrost. No. 1935–1G.

17408. *Whippoorwill* × *Lady*. Grown from Agrost. No. 2027–1.

17409. *Whippoorwill Saddleback*. Grown from Agrost. No. 2025–1.

17410. *Black* × *Blackeye*. Grown from Agrost. No. 2021–1.

17411. Selection from *New Era*. Grown from Agrost. No. 2020–1.

17412. *Speckled Java*. Grown from Agrost. No. 2009–1.

17413. *Calico*. Grown from Agrost. No. 2005–1.

17414. *Coffee*. Grown from Agrost. No. 2008–1.

17415. *Conch*. Grown from Agrost. No. 2013–1.

17416. *Red Whippoorwill*. Grown from Agrost. No. 2003–1.

17417. *Extra Early Blackeye* × *Black*. Grown from Agrost. No. 2018–1.

17418. *Holstein*. Grown from Agrost. No. 2014–1.

17419. *Little Iron*. Grown from Agrost. No. 2006–1.

17420. *Black-Eyed Lady*. Grown from Agrost. No. 2004–1.

17421. Grown from Agrost. No. 2023–1 from the Arkansas Experiment Station.

17422. *Warren's Extra Early* × *Sugar Crowder*. Grown from Agrost. No. 2022–1.

17327 to 17436—Continued.

17423. *Iron Mountain.* Grown from Agrost. No. 2017–1.

17424. *Extra Early Blackeye* × *Black.* Grown from Agrost. No. 2019–1.

17425. *Watson's Hybrid.* Grown from Agrost. No. 2007–1.

17426. *Mount Olive.* Grown from Agrost. No. 2011–1.

17427. *Sport.* Grown from Agrost. No. 2024–1.

17428. *Red Crowder.* Grown from Agrost. No. 2012–1.

17429. Grown from Agrost. No. 2029–1 from the Arkansas Experiment Station.

17430. *Iron.* Grown from Agrost. No. 2136.

17431. *Iron.* Grown from Agrost. No. 2310.

17432. *Michigan Favorite.* Grown from Agrost. No. 2309.

17433. *Iron.* Grown from Agrost. No. 2217.

17434. *Iron.* Grown from Agrost. No. 2386.

17435. *Iron.* Grown from Agrost. No. 2260.

17436. *Iron.* Grown from Agrost. No. 2387.

17437. AGAVE RIGIDA SISALANA. **Sisal.**

From Santiago de las Vegas and Havana, Cuba. Received at the Porto Rico Agricultural Experiment Station, Mayaguez, P. R., May 8, 1906.

"Suckers and rooted bulbils collected from plants growing without cultivation in the vicinity of Havana and Santiago de las Vegas." (*Dewey.*)

17438 to 17448.

From Floral Park, Long Island, N. Y. Received through Mr. John Lewis Childs, February 2, 1906.

17438. STREPTOSOLEN AMABILIS MAGNIFICA.

17439. RICHARDIA FRAGRANS. **Calla.**

17440. RICHARDIA CHILDSIANA. **Calla.**

17441. RICHARDIA AFRICANA NANA COMPACTA. **Little gem calla.**

17442. RICHARDIA PRAECOX. **Calla.**

17443. RICHARDIA AETHIOPICA GIGANTEA. **Calla.**

17444. RICHARDIA ELLIOTTIANA. **Golden calla.**

17445. RICHARDIA ALBO-MACULATA. **Spotted calla.**

17446. RICHARDIA HASTATA. **Yellow calla.**

17447. RICHARDIA AURATA. **Calla.**

17448. RICHARDIA RHEMANNI. **Rose calla.**

17449. MEDICAGO SATIVA. **Alfalfa.**

From Chicago, Ill. Received through the A. Dickinson Company, January 30, 1906.

Utah-grown alfalfa seed.

17450. AVENA SATIVA. **Oat.**

From Richmond, Va. Received through T. W. Wood & Sons, February 1, 1906.

Fall-sown *Appler Rustproof.*

17451. AVENA SATIVA. **Oat.**

From Richmond, Va. Received through T. W. Wood & Sons, January 27, 1906.

Burt.

17452. AVENA SATIVA. **Oat.**

From Augusta, Ga. Received through the N. L. Willet Seed Company, February 1, 1906.

Fall-sown *Appler Rustproof.*

17453 to 17461. XANTHOSOMA spp. **Yautia.**

From Ceylon. Presented by Mr. H. F. Macmillan. Received February 2, 1906.

Roots as follows:

17453. *Kalu Ala.*
17454. *Malanga Blanca.*
17455. *Dehi Ala.*
17456. *Niunie Islenio.*
17457. *Kaudala.*
17458. *Malanga Amarillo.*
17459. *Garendi Kaudala.*
17460. *Desa Ala.*
17461. *Kelu Kaudala.*

17462 and 17463. XANTHOSOMA spp. **Yautia.**

From Cocoanut Grove, Fla. Received through Mr. O. W. Barrett, February 5, 1906.

Honduras varieties.

17464. AVENA SATIVA. **Oat.**

From Yancey, Ga. Received through Mr. H. Yancey, jr., September 28, 1904.

Pure *Appler Rustproof* oats to be planted for the purpose of growing pure stock seed. Hand selected from S. P. I. No. 11722, February, 1906.

17465. NICOTIANA TABACUM. **Tobacco.**

From Portici, Naples, Italy. Presented by Prof. O. Comes. Received May 16, 1906.

Latakia.

17466 to 17470.

From North China. Received through Mr. F. N. Meyer, February 6, 1906.

Plants and cuttings, as follows:

17466. CAREX STENOPHYLLA. **Sedge.**

From Marble Pagoda grounds, Peking. "(Nos. 70b and 70c.) A most wonderful 'grass' for lawns. It will save a tremendous lot of drudgery if we can establish this in the United States, for, according to the gardener of the German legation grounds, it is the only 'grass' in dry North China that keeps green all summer notwithstanding droughts. It grows on the rockiest and poorest of soils and never needs mowing. I consider it of the utmost importance, especially for those regions of the United States where there is but a slight amount of precipitation." (*Meyer.*)

17467. VITIS sp. **Grape.**

From Tientsin. "(Nos. 59, 60, and 61.) A pale purple grape ripening in early September; produces large bunches and is a heavy bearer. Taste of the berries a trifle watery, but otherwise a good grape. Can be kept in cold storage for a whole year. The vines are buried during the winter months." (*Meyer.*)

17466 to 17470—Continued.

17468. VITIS sp. **Grape.**

From Tientsin. "(Nos. 62, 63, 64, and 65.) A dark purple grape, with somewhat smaller berries than No. 59 (S. P. I. No. 17467); otherwise the same description applies to it." (*Meyer.*)

17469. ROSA sp. **Rose.**

From Peking. "(Nos. 67 and 68.) A semidouble, yellow rose frequently met in the gardens here. Is a very thrifty grower and able to withstand long droughts. The straight young shoots grow from 5 to 8 feet in height." (*Meyer.*)

17470. AMYGDALUS PERSICA. **Peach.**

From Peking. "(No. 69.) Bud sticks from the tree in the grounds of the German legation in Peking, from which one bag of seeds was sent under No. 9a (S. P. I. No. 18262)." (*Meyer.*)

17471. TRITICUM DURUM. **Macaroni wheat.**

From Littleton, Colo. Received through Mr. James B. Mills, February 7, 1906.

Kubanka.

17472. CRATAEGUS sp. **Hawthorn.**

From Shanghai, China. Presented by Rev. J. M. W. Farnham, D. D., of the Chinese Tract Society. Received February 8, 1906.

17473. RUBUS sp. **Himalaya blackberry.**

From Albany, Oreg. Received through Mr. Albert Brownlow, February, 1906.

Himalaya (synonym, *Himalaya Giant*) blackberry. "This blackberry was grown by Mr. Luther Burbank from seeds received by him about 1889 or 1890 from a friend, who stated that they had been gathered high up on the Himalayn Mountains. It was sparingly disseminated by Mr. Burbank on the Pacific coast about 1894. It is reported to be a very vigorous, semitrailing variety, somewhat closely resembling the 'Evergreen' blackberry of Oregon, but, unlike that sort, shedding its leaves in autumn. In western Washington and Oregon it has been found entirely hardy and in most soils yields very large crops of fruit of good size and quality, ripening earlier than the 'Evergreen.' Although not strictly a trailer, its recumbent habit and very strong growth render a trellis advisable in its culture.

"It is distributed at this time with a view to determining its relative hardiness and its adaptability to culture in sections east of the Rocky Mountains." (*Taylor.*)

17474. PISTACIA VERA. **Pistache.**

From Khost, India. Presented by Mr. Philip Parker, of the Indian Irrigation Service, through J. S. Davis, esq., executive engineer, Bannu, Kurum Valley Irrigation Project. Received through Mr. W. T. Swingle, May 21, 1906.

"An unusually interesting deep green variety of the wild nut." (*Swingle.*)

17475. ANDROPOGON SORGHUM. **Kafir corn.**

From Lawrence, Kans. Received through F. Barteldes & Co., April 3, 1906.

17476. MEDICAGO SATIVA. **Alfalfa.**

From Brady, Nebr.

Seed from a single plant. Selected by J. M. Westgate, of this Department, September 28, 1905, in a field belonging to H. K. Peckham, on account of size, drought resistance, hardiness, white flowers, and seeding qualities.

17477. PHYSALIS FRANCHETI. **Ground cherry.**

From Samarkand, Turkestan. Received through Mr. Frank Benton, February 9, 1906.

"(No. 25.) Similar to, if not identical with, No. 18 (S. P. I. 15931) from Caucasus. Pods same color, bright crimson, but longer and more pointed. Fruit seems better in quality and is sold in native bazaars. No. 18 is also eaten sometimes, but is more acrid than No. 25." (*Benton.*)

17478. CUCUMIS MELO. **Winter muskmelon.**

From Erivan, southern Caucasus, Russia. Received through Mr. Frank Benton, January 26, 1906.

"(No. 20.) Locally known as *Dutma*. Medium-sized yellow melon with light green flesh. Good quality. Keeps into the winter if hung up in a cool room. A gardener in Erivan states that it is their practice to cover the fruits, when partly grown, with earth, which is left until autumn." (*Benton.*)

17479. ELAEAGNUS sp. **Oleaster.**

From Wagarschapat, southern Caucasus, Russia. Received through Mr. Frank Benton, January 26, 1906.

"(No. 21.) Seeds of an edible fruit known in Armenian as '*Pschad*,' which grows on a good-sized tree. The flesh of the fruit is dry and mealy, tastes something like that of a banana, but is more acid. Much sought after by children. Probably an Elaeagnus. Collected in October, 1905." (*Benton.*)

17480. CUCUMIS MELO. **Winter muskmelon.**

From Old Samarkand, Turkestan. Received through Mr. Frank Benton, January 22, 1906.

"(No. 22.) Seed of a winter muskmelon purchased in Sart Bazaar at Old Samarkand, Turkestan, in December, 1905. Rather small, oval, yellow melon with dark bronze shading. Flesh light green or yellowish-green. Quality medium. Keeps until midwinter if hung up in a cool room. Ripens when brought into a warm room." (*Benton.*)

17481. CUCUMIS MELO. **Winter muskmelon.**

From Samarkand, Turkestan. Received through Mr. Frank Benton, January 26, 1906.

"(No. 23.) Seed of a winter muskmelon purchased in Samarkand in December, 1905. Large, oblong, yellow melon, with thick, light green flesh, fair quality; weight about 10 pounds. Keeps until midwinter if hung in a cool room. Some bronze shading on outside; may be only a large specimen of No. 22 (S. P. I. No. 17480)." (*Benton.*)

17482. CUCUMIS MELO. **Winter muskmelon.**

From Samarkand, Turkestan. Received through Mr. Frank Benton, January 26, 1906.

"(No. 24.) Rather large, slightly oval in form, yellow outside with heavy bronze shading; flesh light green, good quality. May be only a better specimen of Nos. 22 and 23 (S. P. I. Nos. 17480 and 17481)." (*Benton.*)

17483 to 17487.

From Hamilton, Canada. Received through John A. Bruce & Co., February 12, 1906.

17483. PISUM ARVENSE. **Field pea.**

Golden Vine.

17484. LATHYRUS SATIVUS. **Bitter vetch.**

Grass Pea.

17483 to 17487—Continued.

17485. PISUM ARVENSE. **Field pea.**

White Marrowfat.

17486. PISUM ARVENSE. **Field pea.**

Blackeye Marrowfat.

17487. PISUM ARVENSE. **Field pea.**

Blue Prussian.

17488. PHALARIS CANARIENSIS. **Canary grass.**

From San Jose, Cal. Received through Braslan Seed Growers' Company, February 10, 1906.

17489. AGROPYRON TENERUM. **Slender wheat-grass.**

From Brandon, Manitoba. Received through A. E. McKenzie & Co., February 10, 1906.

17490. ANDROPOGON SORGHUM. **Sorghum.**

From Tyro, Kans. Received through Mr. G. R. Wheeler, February 12, 1906.

Simmon's Cane.

17491. MELILOTUS ALBA. **Sweet clover.**

From Beloit, Wis. Received through Mr. I. M. Buell, February 12, 1906.

17492 and 17493. VIGNA UNGUICULATA. **Cowpea.**

From Arlington Farm, Virginia. Crop of 1905.

17492. Grown from Abyssinian seed, S. P. I. No. 11074.

17493. Grown from Abyssinian seed, S. P. I. No. 11091.

17494 and 17495.

From Auckland, New Zealand. Received through the Auckland Department of Agriculture, February 12, 1906.

17494. DANTHONIA SEMIANNULARIS. **Wallaby grass.**

17495. MICROLAENA STIPOIDES. **New Zealand meadow rice-grass.**

17496 and 17497.

From Lausanne, Switzerland. Presented by Prof. G. Martinet, director, Établissement Fédéral d'Essais et de Controle de Semences à Lausanne, February 12, 1906.

17496. VICIA GLABRESCENS. **Vetch.**

17497. LATHYRUS HETEROPHYLLUS.

17498. KICKXIA ELASTICA.

From Victoria, Kamerun, German West Africa. Received through the Victoria Agricultural Experiment Station, January 26, 1906.

17499 to 17504. NICOTIANA spp. **Tobacco.**

From Portici, Italy. Presented by Prof. O. Comes. Received February 9, 1906.

"A collection of varieties of tobacco forming part of the extensive collection made by Professor Comes, author of various works on tobacco, and especially the work enti-

17499 to 17504—Continued.

tled 'The Races of Tobacco.' Imported for breeding experiments in connection with a search for a disease-resistant strain in North Carolina." (*Fairchild.*)

17499. NICOTIANA TABACUM FRUTICOSA.

Karchiaku.

17500. NICOTIANA TABACUM FRUTICOSA.

Doniaku.

17501. NICOTIANA ALATA PERSICA.

Schiraz.

17502. NICOTIANA RUSTICA TEXANA.

Calcutta.

17503. NICOTIANA RUSTICA BRASILIA.

Dzjouchin Rhau.

17504. NICOTIANA RUSTICA BRASILIA.

Veilchen.

17505 and 17506. CITRUS AURANTIUM. **Orange.**

From Shanghai, China. Presented by Rev. J. M. W. Farnham, D. D. Received February 8, 1906.

Orange seeds, as follows:

17505. From Swatow, China. "A very fine loose-skinned variety; lobes separate easily." (*Farnham.*)

17506. From Canton, China. "A better variety of orange than I have ever eaten in the United States or Europe. Close skin, and lobes not separable." (*Farnham.*)

17507. CITRUS AURANTIUM. **Orange.**

From Algiers, Algeria. Presented by Dr. L. Trabut, government botanist. Received February 8, 1906.

"Seeds of the famous orange *Blida*, which, according to Doctor Trabut's label, is an early variety, having large, sweet fruits and reproducing by seeds. The *Blida* orange is one of the best grown in northern Algeria and, as I understand, these seeds are from selected fruits of this variety." (*Swingle.*)

17508. TRIFOLIUM PRATENSE. **Red clover.**

From Lausanne, Switzerland. Presented by Prof. G. Martinet, director, Etablissement Federal D'Essais et de Controle de Semences a Lausanne. Received February 12, 1906.

Selection with yellow grains.

17509. BETA VULGARIS. **Sugar beet.**

From Fairfield, Wash. Received through Mr. E. H. Morrison. Crop of 1905.

Kleinwanzleben.

17510. QUERCUS CUSPIDATA.

From Yokohama, Japan. Received through Mr. F. N. Meyer from the Yokohama Nursery Company, February 15, 1906.

This is an evergreen oak much used in Japan for hedges, for which it seems admirably suited. Its acorns, although of small size, are of very sweet taste when baked like chestnuts, and when boiled or roasted are regularly sold in Japan for food; not hardy in the northern States.

17511. SECHIUM EDULE. **Chayote.**

From Biloxi, Miss. Presented by Mr. Aristide Hopkins. Received February 15, 1906.

Fruits of a green variety.

17512. PHASEOLUS RADIATUS. **Mung bean.**

From De Quincy, La. Received through Dr. S. A. Knapp, February 16, 1906.

Grown from S. P. I. No. 10527.

17513. ANDROPOGON SORGHUM. **Milo.**

From Memphis, Tenn. Received through Mr. J. E. Bradley, February 16, 1906.

Dwarf.

17514 and 17515.

From Buitenzorg, Java. Presented by Dr. M. Treub, director of the Botanical Gardens. Received February 16, 1906.

Seeds, as follows:

17514. GARCINIA MANGOSTANA. **Mangosteen.**

17515. NEPHELIUM LAPPACEUM. **Rambutan.**

Native of south India and Malay islands and furnishes a fruit similar to the Litchi, namely, the *Rambutan* or *Ramboostan* fruit. All species of Nephelium seem to require rather a moist, mild, forest clime than great atmospheric heat. The fruit is of a bright red color, about 2 inches long, of an oval form, and slightly flattened, and covered with long, soft, fleshy spines or thick hair. Like the other Nepheliums it contains a pleasant acidulous pulp, very grateful in tropical countries.

17516. ZEA MAYS. **Corn.**

From St. Anthony Park, St. Paul, Minn. Received through the Minnesota Agricultural Experiment Station, February, 1906.

Crosby. Grown in 1905 from S. P. I. No. 13570; selected to ears of plump form with 14 rows and over.

17517. ZEA MAYS. **Corn.**

From Simsbury, Conn. Received through Mr. A. R. Dayton, February, 1906.

Crosby. Grown in 1905 from S. P. I. No. 13570; selected from two-eared stalks.

17518. ZEA MAYS. **Corn.**

From Simsbury, Conn. Received through Mr. A. R. Dayton, February, 1906.

Crosby. Grown in 1905 from S. P. I. No. 13570; selected from compact plants with ears low on stalk.

17519. VIGNA UNGUICULATA. **Cowpea.**

From Richmond, Va. Received through T. W. Wood & Sons, February 16, 1906.

Red Carolina. "One of the surest cropping of cowpeas, yielding well in both wet and dry seasons. The vines are not as long as *Black* and *Red Ripper*, but are thicker and bunchier, completely covering the ground, and can be more easily cut and cured. Does well on nearly all classes of soils, and better than any other sort on stiff clay soils. The long pods contain 18 to 20 peas, and are easier and less expensive to pick than the short-podded sorts. We recommend it strongly, believing that our growers will find in it distinct advantages over other kinds." (*Wood & Sons.*)

17520. GLYCINE HISPIDA. **Soy bean.**

From Richmond, Va. Received through T. W. Wood & Sons, February 16, 1906.

Hollybrook Early. "A particularly valuable strain of soy beans, which matures its crop three weeks earlier than the *Mammoth Yellow* soy, and is consequently better adapted for planting in sections north of Virginia, or for planting late in order to make a crop of shelled beans. The yield from the *Hollybrook Early* soy is very nearly equal to that of the *Mammoth Yellow*, and they are sure to make a crop of beans. The *Mammoth Yellow* soy requires the full growing season to mature its crop, and frequently an early frost will cut short the yield of the crop of beans. There is no such danger with *Hollybrook Early* soys, and they will prove to be a distinct and valuable acquisition." (*Wood & Sons.*)

17521. PASSIFLORA QUADRANGULARIS. **Granadilla.**

From Juarez, Chihuahua, Mexico. Presented by Mr. Elmer Stearns. Received February 15, 1906.

17522. CUCUMIS MELO. **Winter muskmelon.**

From Ispahan, Persia. Received through Mr. Frank Benton, February 14, 1906.

"Bears transportation long distances over bad roads; good quality, very juicy, fairly sweet. Long, oval, light yellow or straw colored outside with rather fine brown netting. Rind thin; flesh light straw colored, with a watery or semitransparent appearance. Ispahan is on a great plateau, 5,400 feet above sea level." (*Benton.*)

17523 and 17524.

From Bagdad, Turkey. Presented by Hon. Rudolph Hurner, United States vice-consul. Received February 8, 1906.

17523. ZEA MAYS. **Corn.**

"*Edreh Scham*" (*Damascus Edreh*). Small, yellow flint corn.

17524. ANDROPOGON SORGHUM. **Sorghum.**

"*Edreh Trak*" (or *Irak*).

17525 to 17527.

From Geneva, Idaho. Received through Mr. F. W. Boehme, February, 1906.

17525. HORDEUM VULGARE. **Barley.**

Beardless.

17526. AVENA SATIVA. **Oat.**

Swedish Select.

17527. AVENA SATIVA. **Oat.**

Sixty-Day.

17528 and 17529.

From Niu-chwang, China. Received from the Chinese magistrate of the Haicheng district, through Mr. Thomas Sammons, United States consul-general at Niu-chwang, February 12, 1906.

17528. CANNABIS SATIVA. **Hemp.**

"Manchurian fine thread hemp seed." (*Sammons.*)

17529. ABUTILON AVICENNAE. **China jute.**

"Manchurian coarse rope hemp seed." (*Sammons.*)

17530 to 17533. ARACHIS HYPOGAEA. **Peanut.**

From Mikindani, German East Africa. Presented by Prof. Dr. A. Zimmermann, Biologisch Landwirtschaftliches Institut, Amani, German East Africa. Received February 16, 1906.

No varietal names received.

17534. DOLICHOS ATROPURPUREUS.

From Waterloo, Kans. Received through Mr. J. W. Riggs, February 10, 1906.

17535 to 17537. ANDROPOGON SORGHUM. **Sorghum.**

From Lyallpur, India. Received through Mr. Theodore C. Maller, of Amritsar, India, February 16, 1906.

Sorghum seed, as follows:

17535. *White Juar of Lyallpur.*

17536. *Sweet Juar of Lyallpur.*

17537. *Red Juar of Lyallpur.*

17538 to 17687. ANDROPOGON SORGHUM. **Sorghum.**

From Chillicothe, Tex.

A collection of sorghums grown in 1905 on the Department's experimental farm at Chillicothe, as follows:

17538. *Planter's Friend.* Grown from Agrost. No. 1697, from New South Wales, Australia.

17539. *Planter's Friend.* Grown from Agrost. No. 2119, from Queensland, Australia.

17540. "*S. saccharatum.*" Grown from Agrost. No. 1605, from Sydney, Australia.

17541. *Black-Seeded.* Grown from Agrost. No. 1656, from New South Wales, Australia.

17542. *Black-Seeded.* Grown from Agrost. No. 1694, from New South Wales, Australia.

17543. *Amber.* Grown from Agrost. No. 1695, from New South Wales, Australia.

17544. *Dwarf Amber.* Grown from Agrost. No. 2118, from Queensland, Australia.

17545. *Undendibule.* Grown from Agrost. No. 1752, from Victoria, Australia; first selection.

17546. *Undendibule.* Grown from Agrost. No. 1752, from Victoria, Australia; second selection.

17547. *Orange.* Grown from Agrost. No. 1661, from New South Wales, Australia.

17548. *Orange.* Grown from Agrost. No. 1696, from New South Wales, Australia.

17549. *Orange.* Grown from Agrost. No. 2095, from Congressional seed distribution; first selection.

17550. *Orange.* Grown from Agrost. No. 2095; second selection.

17551. *Orange.* Grown from Agrost. No. 2125, from Queensland, Australia; first selection.

17552. *Orange.* Grown from Agrost. No. 2125; second selection.

17553. *Texas Gooseneck* (*Texas Seeded "Ribbon Cane"*). Grown from Agrost. No. 1812, from the Texas Seed and Floral Company, Dallas, Tex.

17538 to 17687—Continued.

17554. *Sumac.* Grown from Agrost. No. 1946, from the Tennessee Experiment Station.

17555. *Folger's Early.* Grown from Agrost. No. 2120, from Queensland, Australia.

17556. *Colman.* Grown from Agrost. No. 2121, from Queensland, Australia.

17557. *Collier.* Grown from Agrost. No. 2124, from Queensland, Australia; first selection.

17558. *Collier.* Grown from Agrost. No. 2124; second selection.

17559. *Russian Sugar.* Grown from Agrost. No. 1581, from Russia.

17560. *Austrian Sugar.* Grown from Agrost. No. 1607, from Vienna.

17561. *Black Sorghum.* Grown from Agrost. No. 1811, from Barbados, West Indies.

17562. *Yellow Milo.* Grown from Agrost. No. 1753, from Victoria, Australia.

17563. *Yellow Milo.* Selected pendent heads grown from Agrost. No. 2522, from Thorburn & Co., New York, N. Y.

17564. *Yellow Milo.* Selected erect heads grown from Agrost. No. 2522.

17565. *Yellow Milo.* Grown from Agrost. No. 2090, from Chillicothe, Tex.

17566. *Red Kafir.* Grown from Agrost. No. 1751, from Victoria, Australia.

17567. *Red Kafir.* Grown from Agrost. No. 2116, from Queensland, Australia.

17568. *Black-Hulled White Kafir.* Grown from Agrost. No. 1749, from Victoria, Australia.

17569. *Black-Hulled White Kafir.* Grown from Agrost. No. 1993, from the Iowa Seed Company, Des Moines, Iowa.

17570. *White Milo.* Grown from Agrost. No. 2115, from Queensland, Australia.

17571. *White-Hulled White Kafir.* Grown from Agrost. No. 2122, from Queensland, Australia.

17572. *Black-Hulled White Kafir.* Grown from Agrost. No. 1754, from Victoria, Australia.

17573. *Dharla* (A). Grown from S. P. I. No. 14500.

17574. *Kalbondi.* Grown from S. P. I. No. 14508.

17575. *Gare Nasik.* Grown from S. P. I. No. 14516.

17576. *Bile Jura.* Grown from S. P. I. No. 14524.

17577. *Meldani.* Grown from S. P. I. No. 14535.

17578. *Koudi.* Grown from S. P. I. No. 14544.

17579. *Nadyal.* Grown from S. P. I. No. 14583.

17580. *Juari.* Grown from S. P. I. No. 14584.

17581. *White Dumraon.* Grown from S. P. I. No. 14585.

17582. *Gumeri.* Grown from S. P. I. No. 14586; first selection.

17583. *Gumeri.* Grown from S. P. I. No. 14586; second selection.

17584. *Dukri.* Grown from S. P. I. No. 14587.

17585. *Durga.* Grown from S. P. I. No. 14588.

17538 to 17687—Continued.

17586. *Bana of Jalaun.* Grown from S. P. I. No. 14589.
17587. *Bhauna of Jhansi.* Grown from S. P. I. No. 14590.
17588. *Lal.* Grown from S. P. I. No. 14591.
17589. *Doliya.* Grown from S. P. I. No. 14593; first selection.
17590. *Doliya.* Grown from S. P. I. No. 14593; second selection.
17591. *Bania.* Grown from S. P. I. No. 14594.
17592. *Laliya.* Grown from S. P. I. No. 14595.
17593. *Kombrai.* Grown from S. P. I. No. 14597.
17594. *Pyaria Iksari Banda.* Grown from S. P. I. No. 14598.
17595. *Iksari Banda.* Grown from S. P. I. No. 14599.
17596. *Pyaria.* Grown from S. P. I. No. 14600.
17597. *Alapuri.* Grown from S. P. I. No. 14602.
17598. *Dulari.* Grown from S. P. I. No. 14603.
17599. *Dugadia Zard.* Grown from S. P. I. No. 14604.
17600. *Ikdani.* Grown from S. P. I. No. 14605.
17601. *Purbi Magha.* Grown from S. P. I. No. 14606.
17602. *Country White.* Grown from S. P. I. No. 14607.
17603. *Dugadia Safed.* Grown from S. P. I. No. 14608; first selection.
17604. *Dugadia Safed.* Grown from S. P. I. No. 14608; second selection.
17605. *Jogia.* Grown from S. P. I. No. 14609.
17606. *Domni.* Grown from S. P. I. No. 14610.
17607. *Chatka.* Grown from S. P. I. No. 14611.
17608. *Bangra.* Grown from S. P. I. No. 14612.
17609. *Lallu.* Grown from S. P. I. No. 14613; first selection.
17610. *Lallu.* Grown from S. P. I. No. 14613; second selection.
17611. *Purbi Murabad.* Grown from S. P. I. No. 14617.
17612. *Deshi.* Grown from S. P. I. No. 14618.
17613. *Ganga Jamni.* Grown from S. P. I. No. 14619.
17614. *Bannia Dadri.* Grown from S. P. I. No. 14622.
17615. *Red of Ajangarh.* Grown from S. P. I. No. 14626; first selection.
17616. *Red of Ajangarh.* Grown from S. P. I. No. 14626; second selection.
17617. *Bannia.* Grown from S. P. I. No. 14627.
17618. *Jhangaria.* Grown from S. P. I. No. 14631.
17619. *Palarhia.* Grown from S. P. I. No. 14634.
17620. *Ganga Jali.* Grown from S. P. I. No. 14641.
17621. *Lohor.* Grown from S. P. I. No. 14647.
17622. *Shalu.* Grown from S. P. I. No. 14666; first selection.
17623. *Shalu.* Grown from S. P. I. No. 14666; second selection.
17624. *Makchandri.* Grown from S. P. I. No. 14667.
17625. *Holgi.* Grown from S. P. I. No. 14668.
17626. *Hundi.* Grown from S. P. I. No. 14669.
17627. *Kagi Moti.* Grown from S. P. I. No. 14671.

17538 to 17687—Continued.

17628. *Kalbondi.* Grown from S. P. I. No. 14673.
17629. *Duhar Maski.* Grown from S. P. I. No. 14674.
17630. *Bendri.* Grown from S. P. I. No. 14675; first selection.
17631. *Bendri.* Grown from S. P. I. No. 14675; second selection.
17632. *Guldhavi.* Grown from S. P. I. No. 14676.
17633. *Lakdi.* Grown from S. P. I. No. 14677.
17634. *Shalu.* Grown from S. P. I. No. 14678.
17635. *Gola.* Grown from S. P. I. No. 14680.
17636. *Khondi Chandor.* Grown from S. P. I. No. 14684; first selection.
17637. *Khondi Chandor.* Grown from S. P. I. No. 14684; second selection.
17638. *Khondi Chandor.* Grown from S. P. I. No. 14684; third selection.
17639. *Dadar.* Grown from S. P. I. No. 14687.
17640. *Khonde Malegaon.* Grown from S. P. I. No. 14688.
17641. *Shalu.* Grown from S. P. I. No. 14689.
17642. *Dagdi.* Grown from S. P. I. No. 14691.
17643. *Shalu.* Grown from S. P. I. No. 14694.
17644. *Hundi.* Grown from S. P. I. No. 14697.
17645. *Waradi Juar.* Grown from S. P. I. No. 14699.
17646. *Hundi.* Grown from S. P. I. No. 14700.
17647. *Jondhala.* Grown from S. P. I. No. 14701; first selection.
17648. *Jondhala.* Grown from S. P. I. No. 14701; second selection
17649. *Maldani.* Grown from S. P. I. No. 14702.
17650. *Tambdi.* Grown from S. P. I. No. 14703.
17651. *Gudadi.* Grown from S. P. I. No. 14704.
17652. *Jagadi.* Grown from S. P. I. No. 14705.
17653. *Dadia.* Grown from S. P. I. No. 14706.
17654. *Fafaria.* Grown from S. P. I. No. 14707.
17655. *Deshi Perio.* Grown from S. P. I. No. 14708.
17656. *Sholapuri.* Grown from S. P. I. No. 14709.
17657. *Ratadia.* Grown from S. P. I. No. 14713; first selection.
17658. *Ratadia.* Grown from S. P. I. No. 14713; second selection.
17659. *Malvan.* Grown from S. P. I. No. 14718.
17660. *Utavli.* Grown from S. P. I. No. 14719.
17661. *Sakar Makar.* Grown from S. P. I. No. 14720.
17662. *Sundhia* (B). Grown from S. P. I. No. 14721.
17663. *Collier.* Grown from S. P. I. No. 14723.
17664. *Raj Hansa.* Grown from S. P. I. No. 14724.
17665. *Imphee.* Grown from S. P. I. No. 14725.
17666. *Motichur.* Grown from S. P. I. No. 14728.
17667. *Rati* (A). Grown from S. P. I. No. 14733.
17668. *Jogadi.* Grown from S. P. I. No. 14734.
17669. *Kempu Poona.* Grown from S. P. I. No. 14742.
17670. *Kempu* (A). Grown from S. P. I. No. 14744.

17538 to 17687—Continued.

17671. *Holgi Gola.* Grown from S. P. I. No. 14749.

17672. *Dudha Mogra.* Grown from S. P. I. No. 14750.

17673. *Tambdi Sholapuri.* Grown from S. P. I. No. 14751.

17674. *Dukri* (B). Grown from S. P. I. No. 14753.

17675. *Holgi Jola.* Grown from S. P. I. No. 14761.

17676. *Chikna.* Grown from S. P. I. No. 14762.

17677. *Maldandi* (A) *Poona.* Grown from S. P. I. No. 14763.

17678. *Kagi.* Grown from S. P. I. No. 14766.

17679. *Darker.* Grown from S. P. I. No. 14767; first selection.

17680. *Darker.* Grown from S. P. I. No. 14767; second selection.

17681. *Darker* (A). Grown from S. P. I. No. 14768.

17682. *Sundhia Juwar* (Poona Farm). Grown from S. P. I. No. 14769.

17683. *Utavli.* Grown from S. P. I. No. 14771.

17684. *Kavli.* Grown from S. P. I. No. 14772.

17685. *Charodi* (Surat Farm). Grown from S. P. I. No. 14773.

17686. *Ameria Sundhia* (Nadiad Farm). Grown from S. P. I. No. 14774.

17687. *Farfaria* (Nadiad Farm). Grown from S. P. I. No. 14775.

17688. ANDROPOGON SORGHUM. **Sorghum.**

From Chillicothe, Tex. Received through Mr. E. J. Randel. Crop of 1905.

Sapling.

17689. ANDROPOGON SORGHUM. **Sorghum.**

From Mecca, Cal. Received through Brauchman Brothers. Crop of 1905.

Durra.

17690. ANDROPOGON SORGHUM. **Sorghum.**

From Mountain View, Okla. Received through Mr. James Cummins. Crop of 1905.

Shallu.

17691. ANDROPOGON SORGHUM. **Giant milo (?).**

From Chillicothe, Tex. Received through Mr. A. B. Conner. Crop of 1905.

Seed of the Giant milo, or possibly a hybrid, collected from plants found growing in several fields.

17692. ZEA MAYS. **Corn.**

From Dallas, Tex. Received through the Texas Seed and Floral Company, February 20, 1906.

Texas Giant Gourd.

17693. VIGNA UNGUICULATA. **Cowpea.**

From Dallas, Tex. Received through the Texas Seed and Floral Company, February 20, 1906.

Cream.

17694. AVENA SATIVA. **Oat.**

From Manhattan, Kans. Received through the Agricultural Experiment Station, February 20, 1906.

Sixty-Day.

17695. ANDROPOGON SORGHUM. **Sorghum.**

From Waterville, Minn. Received through Mr. Seth H. Kenney, February 20, 1906.

Minnesota Early Amber Cane.

17696. PHASEOLUS RADIATUS. **Mung bean.**

From San Jose, Cal. Received through the Braslan Seed Growers Company, February 23, 1906.

17697. VIGNA UNGUICULATA. **Cowpea.**

From Richmond, Va. Received through T. W. Wood & Sons, February 23,1906.

Iron.

17698. MEDICAGO SATIVA. **Alfalfa.**

From Chinook, Mont. Received through Mr. Thomas O'Hanlon, February 21, 1906.

17699. AGROPYRON OCCIDENTALE. **Western wheat-grass.**

From Harlem, Mont. Received through Mr. Thomas M. Everett, February 21, 1906.

17700 and 17701. AVENA SATIVA. **Oat.**

From Richmond, Va. Received through T. W. Wood & Sons, February 23, 1906.

17700. *Appler Rustproof.* **17701.** *Burt.*

17702. ANDROPOGON SORGHUM. **Sorghum.**

From Richmond, Va. Received through T. W. Wood & Sons, February 23, 1906.

Early Amber Cane.

17703. XANTHOSOMA SAGITTIFOLIUM. **Yautia.**

From Port au Paix, Haiti. Received through Mr. George W. Gulding, February 23, 1906.

17704 to 17707. DIOSPYROS KAKI. **Japanese persimmon.**

From Taiku, Korea. Received through Prof. J. G. Jack, of the Arnold Arboretum, Jamaica Plains, Mass., February 26, 1906.

Cuttings of four varieties of seedless Japanese persimmons.

17708. MUSSAENDA FRONDOSA.

From Manila, P. I. Received through Mr. W. S. Lyon, of the Bureau of Agriculture, February 26, 1906.

"A yellow-flowered, ornamental shrub; flowers subtended by single, large, milk-white calycine leaf; very showy." (*Lyon.*)

17709. ORNITHOPUS SATIVUS. **Serradella.**

From Paris, France. Received through Vilmorin-Andrieux & Co., February 26, 1906.

17710 to 17712. ARACHIS HYPOGAEA. **Peanut.**

From Yokohama, Japan. Received through the Yokohama Nursery Company, February 26, 1906.

Seed of three varieties of peanuts grown in Shimosa Province, as follows:

17710. Small variety.

17711. *Hirata;* the best in Japan; large variety.

17712. *Bachigai* (outsider); large variety.

17713 and 17714. COFFEA ARABICA. **Coffee.**

From Harrar, Abyssinia. Received through the Office of Bionomic Investigations, February 26, 1906.

17713. CULTIVATED COFFEE. **17714.** WILD COFFEE.

17715 and 17716. AGAVE spp. **Century plant.**

From Washington, D. C. Received through Mr. L. H. Dewey, February, 1906.

Plants, as follows:

17715. AGAVE LECHEGUILLA.
From Mexico.

17716. AGAVE RIGIDA SISALANA. **Sisal.**
From the Bahama Islands.

17717. PSOPHOCARPUS TETRAGONOLOBUS. **Seguidillas.**

From Manila, P. I. Presented by Mr. W. S. Lyon, of the Bureau of Agriculture. Received February 26 and April 3, 1906.

"The pods if boiled when exceedingly young and tender taste not unlike asparagus. Vigorous climber, fruiting in three months from the seed and annually from a perennial rootstock in warm climates." (*Lyon.*)

17718 and 17719. VITIS VINIFERA. **Grape.**

From Salonica, Turkey. Received through Rev. J. Henry House, February 15, 1906.

Cuttings, as follows:

17718. *White Kapadjulari.* **17719.** *Black Kapadjulari.*

17720. AVENA SATIVA. **Oat.**

From Aberdeen, S. Dak. Received through Mr. Isaac Lincoln, February 28, 1906.

Sixty-Day.

17721. PAPPOPHORUM NIGRICANS.

From Victoria, Australia. Presented by Prof. Hugh Pye, of the Dookie Agricultural College. Received February 21, 1906.

17722. PHASEOLUS RADIATUS. **Mung bean.**

From Terrell, Tex. Received through W. C. Porter & Co., February 28, 1906.

Probably grown from No. 10527.

17723 to 17743.

From China. Received through Mr. F. N. Meyer, March 1, 1906.

A collection of bud sticks, as follows:

17723. Pyrus sinensis. **Pear.**

From Matou. "(No. 75.) A fine variety of a melting pear called *Pai li*. This form looks to be different from those sent under Nos. 109 and 120 (S. P. I. No. 16911)." (*Meyer.*)

17724. Pyrus sinensis. **Pear.**

From Matou. "(No. 73.) A large variety of the best pear of North China, the so-called Peking pear; in Chinese, *Ya kwam le*. Looks and smells like a quince, but is juicy, melting, and aromatic. May prove to be exceedingly valuable for breeding purposes. The trees grow far more spread out than pears generally do, so they must not be planted too close." (*Meyer.*)

17725. Pyrus sinensis. **Pear.**

From Matou. "(No. 74.) A small variety of the best pear of North China. The same description as for No. 73 serves this one, only it is a far smaller variety and, as such, does not appear on the tables of the best hotels in China." (*Meyer.*)

17726. Pyrus sinensis. **Pear.**

From Matou. "(No. 76.) A large variety of a juicy pear with nonmelting flesh. A very good keeper of fine appearance; somewhat like our *Kieffer* pear. May be most excellent for canning purposes." (*Meyer.*)

17727. Pyrus sp. **Pear.**

From Tsing-ho-pu. "(No. 125.) A wild pear bearing fruits not larger than a hollyberry. Makes an extraordinarily dense head of branches and may be of use in small parks where small shade trees are wanted." (*Meyer.*)

17728. Amygdalus persica. **Peach.**

From Matou. "(No. 82.) A peach described to me by the natives as very large, red meated, and juicy. The trees are thrifty growers." (*Meyer.*)

17729. Amygdalus davidiana.

From the mountains near Tang-shan, near Peking. "(No. 126.) A variety of thrifty growth, with medium-sized buds. Fruits absolutely inedible, but may prove to be very valuable as a spring flowering shrub. The Chinese cultivate many different varieties as dwarfed specimens and for winter forcing." (*Meyer.*)

17730. Amygdalus davidiana.

From the mountains near Tang-shan, near Peking. "(No. 127.) A variety of rather stunted growth, with large-sized buds. May prove to be a valuable addition to our spring flowering shrubs." (*Meyer.*)

17731. Amygdalus davidiana.

From the mountains near Tang-shan, near Peking. "(No. 129.) A very diminutive form of wild peach. Grows in very rocky places and has small, silvery-white twigs. May be of use as a shrub for rockeries." (*Meyer.*)

17732. Prunus sp. **Cherry.**

From Pee-san. "(No. 79.) A bush cherry bearing small, red fruits which ripen here in early June. Is grafted upon wild peach stock low down in the ground." (*Meyer.*)

17733. Prunus sp. **Cherry.**

From Pee-san. "(No. 80.) A larger variety than No. 79; otherwise the the same description applies to it." (*Meyer.*)

17723 to 17743—Continued.

17734. PISTACIA CHINENSIS. **Pistache.**

From Wei-tsan Mountains. "(Nos. 71 and 90.) The staminate form of the Chinese pistache. A very ornamental tree with graceful, pinnate foliage; grows to very large dimensions." (*Meyer.*)

17735. PISTACIA CHINENSIS. **Pistache.**

From Wei-tsan Mountains. "(Nos. 72 and 89.) The carpellate form of the Chinese pistache. A rather ornamental, small tree; bears heavy bunches of small, scarlet, and purplish colored berries." (*Meyer.*)

17736. AESCULUS CHINENSIS. **Chinese horse-chestnut.**

From Wei-tsan Mountains. "(No. 81.) An ornamental shade tree with somewhat smaller leaves than the ordinary horse-chestnut; when old gets to be very spreading. A very rare tree in north China and entirely new to America." (*Meyer.*)

17737. SALIX sp. **Willow.**

From Scha-ho-schoun. "(Nos. 121 and 122.) A remarkable willow which forms naturally a dense, flat-globular head." (*Meyer.*)

17738. SALIX sp. **Willow.**

From the mountains near Tang-shan, near Peking. "(No. 133.) A willow with bright yellow bark, found in a ravine." (*Meyer.*)

17739. CRATAEGUS PINNATIFIDA. **Hawthorn.**

From Matou. "(No. 131.) A variety differing in growth from those sent under No. 9 (S. P. I. No. 17171.) According to the natives, the fruits are of large size. Grown as an ornamental as well as a fruit tree." (*Meyer.*)

17740. CATALPA BUNGEI. **Catalpa.**

From Fung-tai. "(No. 138.) Probably a different form of this beautiful tree from those sent under No. 13 (S. P. I. No. 16914)." (*Meyer.*)

17741. MALUS sp. **Crab apple.**

From Fung-tai. "(No. 139.) An ornamental, red-flowered shrub, common in Chinese gardens. Probably adapted to dry places." (*Meyer.*)

17742. POPULUS sp. **Poplar.**

From Matou. "(No. 77.) A poplar with small leaves and black-colored bark; grown as a wind-break on very sandy soils." (*Meyer.*)

17743. POPULUS sp. **Poplar.**

From Matou. "(No. 132.) A silvery-barked poplar; grown as a wind-break on very sandy soils." (Meyer).

17744 to 17755.

From Chi-li Province, China. Received at the Plant Introduction Garden, Chico, Cal., through Mr. F. N. Meyer, January 23, 1906.

A miscellaneous collection of roots and bud sticks, as follows:

17744. RUBUS sp.

From Shan-hai-kwan. "(No. 6.) A Rubus found in a semishady, dry situation. At the time of collection no fruits were present." (*Meyer.*)

17745. JUGLANS REGIA. **Persian walnut.**

From Chang-li. "(No. 8.) Scions from a soft-shell walnut tree, which produces, according to the owner, on some branches also paper-shell nuts. Nuts sent to Washington, D. C., under 51a (S. P. I. No. 17945)." (*Meyer.*)

17744 to 17755—Continued.

17746. JUGLANS REGIA. **Persian walnut.**

From Chang-li. "(No. 45.) A paper-shell walnut, of which nuts were sent to Washington, D. C., under No. 36a (S. P. I. No. 17946)." (*Meyer.*)

17747. JUGLANS REGIA. **Persian walnut.**

From Chang-li. "(No. 48.) A large nut with medium soft shell." (*Meyer.*)

17748. FRAXINUS LONGICUSPIS (?). **Ash.**

From Shan-hai-kwan. "(Nos. 11 and 19.) An ash which assumed fine, reddish brown tints at the time of collecting. The leaves are not as large or as pinnate as those of *Fraxinus excelsior*. The tree is decidedly ornamental." (*Meyer.*)

17749. (Undetermined.)

From Shan-hai-kwan. "(No. 41.) A shrubby Lespedeza, growing between rocks." (*Meyer.*)

17750. (Undetermined.)

From Shan-hai-kwan. "(No. 43.) A perennial leguminous plant with trifoliate leaves and climbing, semiwoody stems, which are extremely tenacious and are used by the Chinese in tying grapes to trellises and in upholding heavily loaded branches of fruit trees. Is the same as No. 110 (S. P. I. No. 17162)." (*Meyer.*)

17751. CRATAEGUS sp. **Hawthorn.**

From Chang-li. "(No. 42.) The same as No. 10 (S. P. I. No. 17170); used as stock for *Crataegus pinnatifida*." (*Meyer.*)

17752. ZIZYPHUS SATIVA. **Jujube.**

From Chang-li. "(No. 44.) A large variety of the Chinese 'date'; is grown in large orchards by the Chinese and is used either fresh or dried. The trees are planted from 5 to 10 feet apart, and the bark is ringed to make them bear more heavily." (*Meyer.*)

17753. PINUS sp. **Pine.**

From Chang-li. "(No. 57.) Found growing wild in the mountains; is rather stunted when older, but looks extremely characteristic. Used by the natives to plant in graveyards." (*Meyer.*)

17754. DAUCUS CAROTA. **Carrot.**

From Chang-li. "(No. 58.) A blood red carrot; a very sweet variety used cooked and pickled." (*Meyer.*)

17755. VITIS sp. **Grape.**

From Tientsin. "(No. 66.) A light purple grape with rather small berries; otherwise the same description applies to it as to those sent under Nos. 59 and 65 (S. P. I. Nos. 17467 and 17468)." (*Meyer.*)

17756 and 17757. ANDROPOGON SORGHUM. **Sorghum.**

From Lawrence, Kans. Received through F. Barteldes & Co., March 2, 1906.

17756. *Colman Orange Cane.* **17757.** *African.*

17758 to 17832.

From Glasnevin, Dublin, Ireland. Received from the Royal Botanic Gardens, March 2, 1906.

A collection, mostly of grass and leguminous forage plants seeds, as follows:

17758. Erodium absinthioides.
17759. Erodium cheilanthifolium.
17760. Erodium chelidonifolium.
17760a. Erodium gruinum.
17761. Erodium hymenodes.
17762. Erodium manescavi.
17763. Erodium pelargoniflorum.
17764. Erodium semenovii.
17765. Erodium trichomanifolium.
17766. Erodium verbenaefolium.
17767. Galega biloba.
17768. Galega persica.
17769. Lathyrus armitageanus.
17770. Lathyrus cruikshankii.
17771. Lathyrus gorgoni.
17772. Lathyrus latifolius.
17773. Lathyrus nissolia.
17774. Lathyrus odoratus.
17775. Lathyrus pyrenaicus.
17776. Lathyrus rotundifolius.
17777. Lathyrus sibthorpii.
17778. Medicago decandollii.
17779. Medicago elegans.
17780. Medicago intertexta.
17781. Medicago orbicularis.
17782. Medicago scutellata.
17783. Medicago tuberculata.
17784. Melilotus leucantha.
17785. Onobrychis caput-galli.
17786. Onobrychis crista-galli.
17787. Scorpiurus muricatus.
17788. Scorpiurus subvillosus.
17789. Scorpiurus vermiculata.
17790. Vicia grandiflora.
17791. Vicia orobus.
17792. Vicia sylvatica.
17793. Aegilops macrochaeta.
17794. Aegilops macrura.
17795. Aegilops ovata.
17796. Aegilops squarrosa.
17797. Aegilops triaristata.
17798. Aegilops triuncialis.
17799. Agropyron acutum.
17800. Agropyron muricatum.
17801. Arrhenatherum avenaceum.
17802. Arrhenatherum avenaceum bulbosum.
17803. Avena argentea.
17804. Avena atropurpurea.
17805. Avena orientalis.
17806. Dactylis altaica.
17807. Dactylis glaucescens.
17808. Dactylis hispanica.
17809. Hierochloe borealis.
17810. Holcus argenteus.
17811. Pennisetum caudatum.
17812. Pennisetum latifolium.
17813. Phalaris coerulescens.
17814. Phalaris trigyna.
17815. Phleum arenarium.
17816. Phleum asperum.
17817. Phleum boehmeri.
17818. Phleum intermedium.
17819. Phleum michelii.
17820. Phleum parnassicum.
17821. Phleum pratense.
17822. Phleum tenue.
17823. Brachypodium pinnatum.
17824. Agropyron repens.
17825. Triticum vulgare (?)
17826. Agropyron cristatum.
17827. Agropyron elymoides.
17828. Triticum firmum.
17829. Agropyron repens.
17830. Triticum turgidum.
17831. Agropyron repens.
17832. Dianthus squarrosus.

17833 and 17834. ANDROPOGON SORGHUM. **Sorghum.**

From Des Moines, Iowa. Received through the Iowa Seed Company, March 3, 1906.

Amber Cane.

17835 and 17836. IPOMOEA spp.

From Miami, Fla. Received through the Subtropical Laboratory and Garden (Nos. 185 and 186), March 5, 1906.

17835. Seed of a yellow-flowered variety of Ipomoea; origin, Cuba. (No. 186.)

17836. Seed of a purple-flowered variety of Ipomoea; origin, Jamaica, British West Indies. (No. 185.)

17837 to 17841.

From New York, N. Y. Received through Henry Nungesser & Co., March 5, 1906.

Grass and forage crop seeds, as follows:

17837. AGROSTIS ALBA. **Redtop.**

17838. FESTUCA ELATIOR. **Tall fescue.**

17839. ORNITHOPUS SATIVUS. **Serradella.**

17840. TRIFOLIUM PRATENSE. **Red clover.**

17841. TRIFOLIUM INCARNATUM. **Crimson clover.**

The ordinary or early crimson clover.

17842 to 17954.

From Peking, China. Received through Mr. F. N. Meyer, February 23, 1906.

A collection of seeds, as follows:

17842. QUERCUS DENTATA. **Oak.**

From Ming Tombs. "(No. 25a.) Seed obtained from the same tree as that sent under No. 12a (S. P. I. No. 18265); secured later in the season, the green leaves having changed to a gorgeous red. Probably the same as No. 24a (S. P. I. No. 17879)." (*Meyer.*) (For description see No. 18265.)

17843. (Undetermined.)

From Peking. "(No. 122a.) Seed of a plant bearing bright scarlet-colored nonedible fruits about the size of an egg." (*Meyer.*)

17844. PRUNUS ARMENIACA. **Apricot.**

From Peking. "(No. 15a.) Seed of a sweet variety of apricot sold in Peking under the name of 'almonds'; are eaten as dessert and also used in confectionery." (*Meyer.*)

17845. PRUNUS ARMENIACA. **Apricot.**

From Peking. "(No. 16a.) Seed of a bitter variety of apricot sold in Peking under the name of 'almonds'; used only in confectionery. (*Meyer.*)

17846. ARISTOLOCHIA sp.

From Shan-hai-kwan. (No. 134a.)

17847. PHASEOLUS ANGULARIS. **Adzuki bean.**

From Chang-li. "(No. 37a.) Considered to be the best table bean in Chang-li." (*Meyer.*)

17842 to 17954—Continued.

17848. PHASEOLUS RADIATUS. **Mung bean.**

From Chang-li. "(No. 43a.) A small, edible bean; is grown between rows of sweet potatoes and also cotton; ripens before either of these crops are ready to be harvested." (*Meyer.*)

17849. VIGNA UNGUICULATA. **Cowpea.**

From Tientsin. "(No. 144a.) Used for food; also roasted for confectionery." (*Meyer.*)

17850. PHASEOLUS CALCARATUS. **Bean.**

From Shan-hai-kwan. "(No. 46a.) A small, long bean differing in shape from all other beans; used for food, especially in soups." (*Meyer.*)

17851. PHASEOLUS ANGULARIS. **Adzuki bean.**

From Tientsin. "(No. 143a.) A variety of bean used for food; also for confectionery. The beans are boiled, made in a pulp, sweetened with sugar, and baked in small cakes." (*Meyer.*)

17852. GLYCINE HISPIDA. **Soy bean.**

From Peking. "(No. 17a.) These beans are roasted and sold in Peking as delicatessen." (*Meyer.*)

17853. VICIA FABA. **Broad bean.**

From Shan-hai-kwan. "(No. 45a.) A green variety of broad bean; apparently a different strain." (*Meyer.*)

17854. RICINUS COMMUNIS. **Castor oil plant.**

From Peking. "(No. 61a.) The ordinary castor oil bean. The oil is extracted from the seeds and used in the native lamps. After frost the stalks are uprooted and used for fuel." (*Meyer.*)

17855. VIGNA UNGUICULATA. **Cowpea.**

From Shan-hai-kwan. "(No. 44a.) A light-colored bean used as food; grown between millet and sweet potatoes." (*Meyer.*)

17856. VIGNA UNGUICULATA. **Cowpea.**

From Shan-hai-kwan. "(No. 47a.) A light brown-colored bean used for food in the green and dried state; grown between rows of small millet and sweet potatoes." (*Meyer.*)

17857. GLYCINE HISPIDA. **Soy bean.**

From Shan-hai-kwan. "(No. 42a.) Used for food in Shan-hai-kwan." (*Meyer.*)

17858. PHASEOLUS VULGARIS. **Bean.**

From Tientsin. "(No. 81a.) A fine variety of Red Haricot beans; eaten when green." (*Meyer.*)

17859. PHASEOLUS VULGARIS. **Bean.**

From Peking. "(No. 18a.) *White Haricot.* These are eaten boiled as dry beans, or are used as a vegetable when fresh, and as such they are very fine. Might do well as string beans in the Atlantic States." (*Meyer.*)

17860. VICIA FABA. **Horse bean.**

From Tchang-ping-tcho. "(No. 115a.) A horse bean used for food in north China." (*Meyer.*)

17861. GLYCINE HISPIDA. **Soy bean.**

From Sachon. "(No. 28a.) A small, black soy bean grown for fodder; late variety. An excellent food for stock; must be boiled before being fed." (*Meyer.*)

17842 to 17954—Continued.

17862. GLYCINE HISPIDA. **Soy bean.**

From Tientsin. "(No. 152a.) A fine variety of soy bean used to make bean cheese from." (*Meyer.*)

17863. FAGOPYRUN ESCULENTUM. **Buckwheat.**

From Shan-hai-kwan. "(No. 48a.) A variety of buckwheat sparsely grown around Shan-hai-kwan; used for making bread." (*Meyer.*)

17864. BRASSICA PE-TSAI. **Pe-tsai cabbage.**

From Shan-hai-kwan. "(No. 58a.) An excellent, white, long-headed cabbage, which can be kept in cellars all winter. The plants love a rich, well-worked soil and can not stand drought. The Chinese irrigate them carefully, for the more they are irrigated the larger they grow. Chinese name *Pai tsay.*" (*Meyer.*)

17865. BRASSICA PE-TSAI. **Pe-tsai cabbage.**

From Tientsin. "(No. 83a.) A very small variety of green cabbage." (*Meyer.*) Apparently a mixture of several species.

17866. BRASSICA PE-TSAI. **Pe-tsai cabbage.**

From Tchang-ping-tcho. "(No. 80a.) A very heavy, long-headed white cabbage; late variety." (*Meyer.*)

17867. BRASSICA CHINENSIS. **Pak-choi cabbage.**

From Tientsin. "(No. 100a.) A short cabbage of which the midribs of the leaves get to be quite fleshy. Sold in Tientsin, but as yet I have not seen it anywhere else." (*Meyer.*)

17868. BRASSICA PE-TSAI. **Pe-tsai cabbage.**

From Chang-li. "(No. 1a.) A remarkably fine variety of white cabbage; the best I have ever seen. It is a long-headed variety and grows from 2½ to 3 feet high. The taste and smell are entirely different from any other cabbage. A very fine vegetable. Wants careful culture and can not stand drought. Known as *Shantung* cabbage." (*Meyer.*)

17869. BRASSICA PE-TSAI. **Pe-tsai cabbage.**

From Shan-hai-kwan. "(No. 101a.) Sold to me as a *Shantung* cabbage; a very good variety." (*Meyer.*)

17870. DAUCUS CAROTA. **Carrot.**

From Hsuen-hwa-fu. "(No. 30a.) A sweet, light yellow, nearly white carrot. Grows on alkaline soil." (*Meyer.*)

17871. DAUCUS CAROTA. **Carrot.**

From Tientsin. "(No. 82a.) An orange colored, medium short variety of the ordinary carrot; more in favor here than the beet-red variety." (*Meyer.*)

17872. DAUCUS CAROTA. **Carrot.**

From Tchang-ping-tcho. "(No. 66a.) A very sweet, beet-red carrot. Is used boiled as well as pickled. Loves a well-drained soil and does not want to suffer from drought." (*Meyer.*)

17873. CELASTRUS PANICULATUS (?).

From Shan-hai-kwan. "(No. 123a.) A very large variety found growing in the mountains near Shan-hai-kwan." (*Meyer.*)

17874. CELASTRUS PANICULATUS (?).

From Shan-hai-kwan. "(No. 124a.) A very small variety found growing in the mountains near Shan-hai-kwan." (*Meyer.*)

17875. CELTIS sp.

From Tang-san. ("No. 92a.) A rather large-leaved *Celtis;* useful as a small shade tree." (*Meyer.*)

17842 to 17954—Continued.

17876. CASTANEA SATIVA. **Chestnut.**

From Peking. "(No. 33a.) The largest variety to be found on the markets in Peking; said to have come from Chee-san, near Chang-li. The nuts are roasted with sand and an oily substance which bleaches them, and are remarkably sweet. The trees on which they grow are seedlings." (*Meyer.*)

17877. CASTANEA SATIVA. **Chestnut.**

From Peking. "(No. 34a.) The ordinary Chinese chestnut, sold everywhere in northern China. They are very small, but make up in sweetness what they lack in size. Are roasted the same as No. 33a (S. P. I. No. 17876), and are said to have come from Chee-san, near Chang-li. The trees I saw there grow in sheltered spots and seem to love a rocky soil." (*Meyer.*)

17878. QUERCUS sp. **Oak.**

From western hills near Peking. "(No. 26a.) A fine oak, resembling a chestnut. The acorns are eagerly collected and used for tanning purposes. Probably not very hardy, as it grows in quite sheltered valleys." (*Meyer.*)

17879. QUERCUS DENTATA. **Oak.**

From Tang-san. "(No. 24a.) A beautiful, large-leaved oak. The leaves assume gorgeous colors in autumn; a very desirable tree. Grows to medium dimensions." (*Meyer.*)

17880. ZEA MAYS. **Corn.**

From Pee-san. "(No. 19a.) A very fine strain of corn growing in a rather dry part of the country. This is one of the best varieties I have seen in northern China. The plants grow about six feet high and have uniformly two ears to each stalk." (*Meyer.*)

17881. ZEA MAYS. **Corn.**

From Shan-hai-kwan. "(No. 20a.) A white-seeded corn growing on stony soil around Shan-hai-kwan, where it gets quite cold." (*Meyer.*)

17882. CRATAEGUS PINNATIFIDA. **Hawthorn.**

From Chang-li. "(No. 52a.) The largest variety of *Cretaegus pinnatifida*. A fine fruit for preserves, and a very ornamental tree; is simply loaded in the fall with red berries and keeps its large, glossy, green leaves till late in autumn." (*Meyer.*)

17883. CRATAEGUS PINNATIFIDA. **Hawthorn.**

From Chang-li. "(No. 104a.) Fruits of different sizes to show variation." (*Meyer.*)

17884. DOLICHOS LABLAB. **Hyacinth bean.**

From western hills near Peking. "(No. 96a.) The same as No. 95a (S. P. I. No. 17885), but from a different locality." (*Meyer.*)

17885. DOLICHOS LABLAB. **Hyacinth bean.**

From Hawai-jou. "(No. 95a.) A bean which is grown around gardens as a windbreak, and at the same time the green beans are used as a vegetable; they are somewhat coarse but do not taste at all bad. The plant is a climber and as such needs supports." (*Meyer.*)

17886. ELAEAGNUS sp.

From Chang-li. "(No. 120a.) A silvery-leaved Elaeagnus which ripens small, red berries in October. Grows from 5 to 6 feet high. Under cultivation it might become denser headed and be an ornamental shrub." (*Meyer.*)

17887. MALUS sp. **Crab apple.**

From Peking. (Not numbered by Meyer.) "A crab apple sold on the streets in Peking." (*Meyer.*)

17842 to 17954—Continued.

17888. GLEDITSIA sp.

From Hwai-lai. "(No. 109a.) A small tree; may be fit for a shade tree. Can apparently stand lots of cold and drought, as I found them growing on the edges of a ravine on the road to Mongolia." (*Meyer.*)

17889. GLEDITSIA sp.

From Wei-tsan Mountains near Peking. "(No. 106a.) An ornamental shade tree, bearing dark-brown pods. Apparently a slow grower." (*Meyer.*)

17890. CORYLUS sp. **Hazelnut.**

From Peking. "(No. 32a.) A small hazelnut said to have come from very far north; bought in Peking." (*Meyer.*)

17891. HUMULUS sp. **Hop.**

From Tientsin. "(No. 136a.) A wild hop found growing around here along banks and in thickets." (*Meyer.*)

17892. ZIZYPHUS SATIVA. **Jujube.**

From Peking. "(No. 14a.) The Chinese collect the fruit and make a paste from it by boiling the fruit and straining the liquid. It is a bad weed that easily overruns dry plains. It grows over the whole Peking city wall and its spines easily break off in one's flesh. To be used for breeding purposes." (*Meyer.*)

17893. JUNIPERUS CHINENSIS. **Chinese juniper.**

From Tang-san. "(No. 71a.) Seeds from a very pyramidal form of the juniper. These are universally used in northern China to plant around graves, and also as windbreaks. They seem to be able to withstand much drought." (*Meyer.*)

17894. KOELREUTERIA PANICULATA. **Varnish tree.**

From Ming Tombs. "(No. 85a.) Seed from the bladderpod tree, varying in looks from the usual type." (*Meyer.*)

17895. BRASSICA OLERACEA. **Kohlrabi.**

From Hsuen-hwa-fu. "(No. 73a.) A very large variety of kohlrabi grown where the soil is strongly alkaline." (*Meyer.*)

17896. CASTANEA SATIVA. **Chestnut.**

From Tientsin. "(No. 146a.) A large variety of chestnut sold on Tientsin market; very sweet when boiled or roasted." (*Meyer.*)

17897. ACER sp. **Maple.**

From Tang-san. "(No. 27a.) A very beautiful maple which grows to be a medium-sized tree, of very characteristic form. The leaves assume gorgeous colors in the fall." (*Meyer.*)

17898. ACER sp. **Maple.**

From Wei-tsan Mountains near Peking. "(No. 67a.) An ornamental, small-leaved maple, growing wild in the mountains." (*Meyer.*)

17899. CHAETOCHLOA ITALICA. **Millet.**

From Chang-li. "(No. 53a.) A small variety of millet sold in Chang-li, where it is ground up and used for food." (*Meyer.*)

17900. CHAETOCHLOA ITALICA. **Millet.**

From Chang-li. (No. 105a.)

17901. CHAETOCHLOA ITALICA. **Millet.**

From Chang-li. "(No. 50a.) A variety of medium-sized millet, growing about 5 feet high; stools out very much and is, consequently, a great straw producer. The seeds are used as food, but are not valued as highly as other millets on account of the difficulty of hulling them." (*Meyer.*)

17842 to 17954—Continued.

17902. AMYGDALUS PERSICA. **Peach.**

From Peking. "(No. 88a.) Seed from fruits, among which were some strange types, eaten in different places in north China." (*Meyer.*)

17903. AMYGDALUS PERSICA. **Peach.**

From Shan-hai-kwan. "(No. 89a.) A hardy variety which can probably be grown very far north." (*Meyer.*)

17904. PERILLA OCYMOIDES. **Perilla.**

From Peking. "(No. 79a.) A plant grown in some localities for the production of oil, which is obtained from the seed." (*Meyer.*)

17905. DIOSPYROS LOTUS. **Persimmon.**

From Chang-li. "(No. 69a.) A long-fruited, wild persimmon. The fruits are small and not borne in such great quantities as No. 57a (S. P. I. No. 17906); otherwise the same description applies to it." (*Meyer.*)

17906. DIOSPYROS LOTUS. **Persimmon.**

From Chang-li. "(No. 57a.) A round-fruited, wild persimmon. The fruits are not larger than a cherry, but are very sweet tasting and the trees are heavily loaded. A valuable acquisition as a fruit and ornamental tree, also as a stock plant for the large, seedless persimmon." (*Meyer.*)

17907. DIOSPYROS LOTUS. **Persimmon.**

From Nankon Pass. "(No. 31a.) Seed of the wild persimmon collected from old trees growing at elevated points and apparently at the northern limit of their kind. To be used as stock for the large, seedless persimmon, and also for its fruit and as an ornamental." (*Meyer.*)

17908. RHAMNUS sp.

From Shan-hai-kwan. "(No. 132a.) A very small, shrubby Rhamnus growing wild in the mountains. Well fit for rockeries and as a very small hedge plant." (*Meyer.*)

17909. RHAMNUS sp.

From Tang-san. "(No. 126a.) A large-leaved, bushy Rhamnus from 3 to 6 feet in height; loaded at time of collection with black berries. Might do well as a hedge plant, as it has long spines and is very dense." (*Meyer.*)

17910. PINUS sp. **Pine.**

From Chang-li. "(No. 129a.) The common pine found growing in Chinese cemeteries." (*Meyer.*)

17911. PINUS BUNGEANA. **Pine.**

From Ming Tombs. (No. 108a.) The same as S. P. I. No. 17912.

17912. PINUS BUNGEANA. **Pine.**

From Wei-tsan Mountains. "(No. 137a.) A very beautiful pine with silvery white bark; a slow grower, but extremely striking when old. The bark peels off in flakes, like the sycamore, but the foliage is not as dense as in most other pines." (*Meyer.*)

17913. PRUNUS sp. **Plum.**

From Peking. "(No. 90a.) Apparently a very late plum; freestone; fruits not very large, yellowish green with a purplish bloom; rather sweet in taste." (*Meyer.*)

17914. ORYZA SATIVA. **Rice.**

From Shan-hai-kwan. "(No. 49a.) A variety of upland rice said to be a softer quality than the one sent under No. 40a (S. P. I. No. 17915)." (*Meyer.*)

17915. ORYZA SATIVA. **Rice.**

From Shan-hai-kwan. "(No. 40a.) An upland rice grown sparingly around here. Should be hardy very far north." (*Meyer.*)

17842 to 17954—Continued.

17916. Oryza sativa. **Rice.**

From Sachon. "(No. 29a.) Bought as an upland rice, but apparently is a lowland variety. Should do well quite far north, as the place where it was raised is about 50 miles north of Peking." (*Meyer.*)

17917. Oryza sativa. **Rice.**

From Chang-li. "(No. 39a.) An upland rice cultivated around Chang-li. Should be hardy pretty far north." (*Meyer.*)

17918. Celastrus flagellaris.

From Wei-tsan Mountains, near Peking. "(No. 68a.) A small, creeping shrub, bearing red, edible berries." (*Meyer.*)

17919. Sesamum indicum. **Sesame.**

From Tientsin. "(No. 149a.) These seeds are universally used throughout China in confectionery and baked on the surface of round cakes, and as such they taste pretty good. The plants seem to like a rather rich soil, and produce many seed pods on one stalk. The Chinese also make an oil out of the seed, in which they fry nearly everything." (*Meyer.*)

17920. Andropogon sorghum. **Sorghum.**

From Pee-san. "(No. 21a.) This variety has white seeds and is used for making bread; as such it is more highly esteemed than the brown-colored varieties, which are generally only used as fodder for the domestic animals." (*Meyer.*)

17921. Andropogon sorghum. **Sorghum.**

From Pee-san. "(No. 22a.) A variety with dark brown seeds, universally used throughout north China as fodder for domestic animals. The stems of sorghum are used in building houses, the stalks being embedded in the mud walls; also for making fences, baskets, mats, tying and roofing material, and for fuel." (*Meyer.*)

17922. Andropogon sorghum. **Sorghum.**

From Pee-san. "(No. 23a.) A variety with light brown seeds, not very much grown. It is used where found as a fodder plant and also for making a brown-colored kind of bread." (*Meyer.*)

17923. Andropogon sorghum. **Sorghum.**

From Tientsin. "(No. 151a.) A superior variety of sorghum which grows from 15 to 20 feet in height. The grain is ground, and from the flour a good kind of bread is made; is used also for the same purpose as the one described under No. 22a (S. P. I. No. 17921). In addition to this the leaves are pulled off before they have turned brown, when they make an excellent cattle food, either fresh or dry. The roots are also dug and used as fuel." (*Meyer.*)

17924. Spinacia oleracea. **Spinach.**

From Tchang-ping-tcho. "(No. 55a.) An exceptionally good winter spinach, which, with a little protection from cold, produces greens the greater part of the winter. The seeds should be sown very thinly, as the plants grow rather large." (*Meyer.*)

17925. Helianthus annuus. **Sunflower.**

From western hills, near Peking. "(No. 59a.) The ordinary, single-headed sunflower, used in China in many ways. The leaves are pulled off and fed to domestic animals; the seeds are eaten as delicatessen, and the stalks are used for fuel." (*Meyer.*)

17926. Thuya orientalis. **Arborvitae.**

From Peking. "(No. 84a.) Seeds collected from old, weather-beaten trees on the grounds of the Temple of Heaven in Peking. Can stand lots of cold and drought." (*Meyer.*)

17842 to 17954—Continued.

17927. NICOTIANA sp. **Tobacco.**

From western hills near Peking. "(No. 62a.) An inferior tobacco much used by the lower classes." (*Meyer.*)

17928. NICOTIANA TABACUM. **Tobacco.**

From Chang-li. "(No. 86a.) A medium quality of tobacco grown around Chang-li." (*Meyer.*)

17929. JUGLANS hyb. (?) **Walnut.**

From Nankon Pass. "(No. 87a.) A very strange walnut. Those with highly undulated surfaces are used as a remedy for stiff fingers, and the smooth ones are eaten. A hard-shelled variety. Probably a hybridization has taken place between *J. mandshurica* and *J. regia sinensis.*" (*Meyer.*)

17930. RAPHANUS SATIVUS. **Radish.**

From Chang-li. "(No. 2a.) A giant red radish; flavor not strong. Seems to like a well-drained, sandy soil. Attains a size of from 3 to 7 inches in diameter." (*Meyer.*)

17931. RAPHANUS SATIVUS. **Radish.**

From San-kai-tien. "(No. 76a.) A red radish of elongated form. Looks very nice when exposed for sale." (*Meyer.*)

17932. RAPHANUS SATIVUS. **Radish.**

From Shan-hai-kwan. "(No. 56a.) A radish with a sweet, fresh taste; is very appetizing if cut lengthwise and eaten raw either before or with meals. These seeds have both the green and red varieties among them." (*Meyer.*)

17933. RAPHANUS SATIVUS. **Radish.**

From Shan-hai-kwan. "(No. 60a.) A late variety of a long, white radish; quite sweet and not at all strong when boiled." (*Meyer.*)

17934. RAPHANUS SATIVUS. **Radish.**

From Shan-hai-kwan. "(No. 74a.) A smaller variety than No. 2 (S. P. I. No. 17930); otherwise the same description applies to it." (*Meyer.*)

17935. RAPHANUS SATIVUS. **Radish.**

From San-kai-tien. "(No. 75a.) A very strange variety, the outside looking like a long, green turnip; wine red colored flesh. Is sliced and eaten raw as a relish." (*Meyer.*)

17936. RAPHANUS SATIVUS. **Radish.**

From Shan-hai-kwan. "(No. 77a.) A green variety; very appetizing if sliced and eaten raw." (*Meyer.*)

17937. RAPHANUS SATIVUS. **Radish.**

From Tientsin. "(No. 78a.) The same as No. 77a (S. P. I. No. 17936), but obtained in a different locality." (*Meyer.*)

17938. AMPELOPSIS sp.

From Tientsin. "(No. 70a.) An ornamental vine well fit to cover trellises or verandas; has deeply laciniate, palmate leaves, and bears yellow berries in the fall. Seems to be very hardy and able to withstand droughts." (*Meyer.*)

17939. AMPELOPSIS sp.

From Tientsin. "(No. 93a.) A vine bearing red berries, similar to No. 70a (S. P. I. No. 17938) but more ornamental." (*Meyer.*)

17940. AMPELOPSIS sp.

From Wei-tsan Mountains near Peking. "(No. 113a.) A vine bearing small, white berries; may be fit for covering fences and rough places." (*Meyer.*)

17842 to 17954—Continued.

17941. VITEX sp.

From Wei-tsan Mountains near Peking. "(No. 116a.) An aromatic plant, the peeled twigs of which are used to make fine baskets, and the flowering tops are dried and used as insect powder." (*Meyer.*)

17942. AMPELOPSIS sp.

From Shan-hai-kwan. "(No. 133a.) A vine with deeply lobed leaves and white berries; may be fit to cover rock fences or waste places." (*Meyer.*)

17943. JUGLANS REGIA. **Persian walnut.**

From Gopo, near Chang-li. "(No. 41a.) A large variety of soft-shelled walnut." (*Meyer.*)

17944. JUGLANS REGIA. **Persian walnut.**

From Peking. "(No. 35a.) A very large walnut bought in Peking." (*Meyer.*)

17945. JUGLANS REGIA. **Persian walnut.**

From Gopo, near Chang-li. "(No. 51a.) A very soft-shelled walnut; can be cracked with the hand. Not a perfect nut, though. These nuts are from one tree, which, according to the owner, produces perfectly shelled nuts on some branches and imperfectly formed ones on other branches." (*Meyer.*)

17946. JUGLANS REGIA. **Persian walnut.**

From Chang-li. "(No. 36a.) This is the genuine paper-shell walnut and as such sells for three times as much money as the hard-shelled varieties. The nuts can be peeled like peanuts. The trees are seedlings and are scattered through the groves." (*Meyer.*)

17947. TRITICUM VULGARE. **Wheat.**

From Chang-li. "(No. 38a.) A sample of the best wheat sold in Chang-li." (*Meyer.*)

17948. ROSA sp. **Rose.**

From Chang-li. "(No. 130a.) A wild rose found growing along earth banks." (*Meyer.*)

17949. WISTARIA CHINENSIS. **Chinese wistaria.**

From Tang-san. (No. 107a.)

17950. ARTEMISIA ANNUA. **Wormwood.**

From Peking. "(No. 111a.) This is the plant on which the people around here graft their chrysanthemums and on which they do well. The Chinese claim the chrysanthemum does better when grafted than when left on its own roots; they also say the grafted plants bear transplanting and lack of water much the best." (*Meyer.*)

17951. XANTHOXYLUM sp.

From Shan-hai-kwan. "(No. 125a.) A fine-leaved Xanthoxylum growing wild in the mountains near Shan-hai-kwan. Attains a height of from 4 to 5 feet, is rather ornamental, and has a very agreeable odor." (*Meyer.*)

17952. XANTHOXYLUM BUNGEI (?).

From Pee-san. "(No. 128a.) Used as a hedge plant. The seeds and fruit capsules furnish the Chinese with pepper; the fruit is pretty pungent." (*Meyer.*)

17953. BRASSICA PE-TSAI. **Pe-tsai cabbage.**

From Shan-hai-kwan. "(No. 72a.) A long-headed cabbage, late variety. Can be kept all winter in a frost-proof cellar." (*Meyer.*)

17954. CYDONIA JAPONICA. **Japanese quince.**

From Peking. "(No. 145a.) A very fragrant quince used in China to perfume a room. Grows in south China." (*Meyer.*)

17955 to 17958.

From Santiago de las Vegas, Cuba. Received through Prof. C. F. Baker, March 6, 1906.

Seeds, as follows:

17955. Bauhinia krugii.

"The finest Bauhinia of the West Indies." (*Baker.*)

17956. Eugenia punicifolia.

"An erect, ornamental shrub with fine flowers and fruit." (*Baker.*)

17957. Canavalia sp. **Knife bean.**

"A nonedible, brown variety producing a great vine." (*Baker.*)

17958. Pachyrhizus angulatus. **Yam bean.**

17959. Clematis sp.

From Hwai-lai, Chi-li Province, China. Received through Mr. F. N. Meyer, February 23, 1906.

"(No. 135a.) A small clematis covering banks along ditches. Its white seed-down makes it appear like snow in the distance; not ornamental." (*Meyer.*)

17960. Arachis hypogaea. **Peanut.**

From Amani, German East Africa. Received through Dr. A. Zimmermann, February 23, 1906.

Peanuts from Mikindani.

17961. Canna flaccida. **Canna.**

From Oneco, Fla. Received through Reasoner Bros., March 9, 1906.

17962. Miscanthus condensatus.

From Yokohama, Japan. Received through Suzuki & Iida, of New York City, March 6, 1906.

17963. Agrostis stolonifera. **Creeping bent-grass.**

From New York, N. Y. Received through Henry Nungesser & Co., March 6, 1906.

17964. Vitis munsoniana. **Mustang grape.**

From Elliotts Key, Fla. Received through Dr. John Gifford, March 7, 1906.

17965 and 17966.

From Brighton Beach, Wash. Received through Mr. A. B. Leckenby, March 9, 1906.

Plants, as follows:

17965. Fatsia horrida. **Devil's-club.**

An araliaceous, densely prickly shrub with palmately lobed leaves and racemed or panicled umbels of small, greenish-white flowers.

17966. Lysichitum camtschatcense. **Skunk cabbage.**

A nearly stemless swamp aroid, with large leaves from a thick, horizontal root stock.

17967. BENINCASA CERIFERA. **Wax-gourd.**

From Manila, P. I. Received through Mr. W. S. Lyon, of the Bureau of Agriculture, March 5, 1906.

"Native name *Condol*. Matures fruit in four months from seed. Grown in Philippine Islands only upon trellises. When sliced and steeped over night in lime water and then boiled in a sugar sirup until it candies, it makes a most delicious glacé fruit." (*Lyon.*) (See No. 2936, Inventory No. 7, for description of this plant.)

17968 to 17972. BETA VULGARIS. **Sugar beet.**

From Lyons, N. Y. Received through the Lyons Beet Sugar Company, March 1906.

Sugar-beet seed, as follows:

17968. *Original Kleinwanzleben.*

Grown by Kleinwanzleben Sugar Company, Kleinwanzleben, Germany.

17969. *Schreiber's Specialitaet.*

Grown by G. Schreiber & Sons, Nordhausen, Germany.

17970. *Elite Kleinwanzleben.*

Grown by Dippe Bros., Quedlinberg, Germany.

17971. *Kleinwanzleben.*

Grown by F. Heine & Co., Hadmersleben, Germany.

17972. *Kleinwanzleben.*

Grown by C. Braune & Co., Bundorf, Germany.

17973 and 17974. BETA VULGARIS. **Sugar beet.**

From Lehi, Utah. Received through the Utah Sugar Company, March, 1906.

17973. *Kleinwanzleben.*

Grown by the Utah Sugar Company, Lehi, Utah.

17974. *Kleinwanzleben.*

Grown by the Fremont County Sugar Company, Sugar City, Idaho.

17975. BETA VULGARIS. **Sugar beet.**

From Caro, Mich. Received through the Peninsula Sugar Refining Company, March 10, 1906.

Kleinwanzleben. Grown by Otto Hoerning & Co., Eisleben, Germany.

17976 to 17980. BETA VULGARIS. **Sugar beet.**

From Owosso, Mich. Received through the Owosso Sugar Company, March 12, 1906.

Sugar beet seed, as follows:

17976. *Kleinwanzleben.*

Grown by Henry Mette & Co., Quedlinberg, Germany.

17977. *Kleinwanzleben.*

Grown by Rabbethge & Giesecke, Kleinwanzleben, Germany.

17978. *Kleinwanzleben.*

Grown by Wohanka & Co., Prague, Bohemia.

17979. *Kleinwanzleben.*

Grown by K. W. Kuhn & Co., Maarden, Holland.

17980. *Elite Kleinwanzleben.*

Grown by Otto Bruenstedt, Schladen-im-Harz, Germany.

17981. ASPARAGUS ACUTIFOLIUS.

From Nice, France. Presented by Dr. A. Robertson-Proschowsky. Received March 12, 1906.

"This is an evergreen plant which is found growing wild here, but never in abundance. It grows both in the woods and on sunny slopes; in some places where it is very dry, receiving no rainfall for two or three years. In such places the stems are short and quite leafy, and it is here only that they sometimes, but rarely, produce seeds. In the shade the plants produce stems several meters in length, climbing either shrubs or trees and hanging down the slopes, where they have a very graceful appearance. Young plants are readily transplanted when the roots are still fibrous, but when they become older and the roots are thick and fleshy it is impossible to transplant them. This asparagus in the wild state is quite a delicacy, and although scarce and sparingly found, the young shoots are eagerly sought for." (*Proschowsky.*)

17982 and 17983. NICOTIANA spp.

From Philadelphia, Pa. Received through Henry A. Dreer, Inc., March 5, 1906.

17982. NICOTIANA SANDERAE.

(See S. P. I. No. 17246.)

17983. NICOTIANA SANDERAE hyb.

(See S. P. I. No. 17247.)

17984. ANDROPOGON SORGHUM. **Sorghum.**

From Canadian, Tex. Received through Mr. Thomas F. Moody, March 10, 1906.

Sourless.

17985. COLOCASIA sp. **Dasheen.**

From Aguas Buenas, P. R. Received through Mr. A. W. Bowser, March 12, 1906.

Identical with S. P. I. No. 15395.

17986. COLOCASIA sp. **Taro.**

From Georgetown, S. C. Received through Mr. John Tull, March 12, 1906.

"Roots of the so-called *Yellow Tanier* of South Carolina. These roots were grown by me last year on Cat Island from roots given to me by Mr. Alex. Lucas, of Santee, S. C." (*Tull.*)

17987. COLOCASIA sp. **Taro.**

From Georgetown, S. C. Received through Mr. John Tull, March 12, 1906.

"Roots of the so-called *White Tanier* of South Carolina. These were grown by me on Cat Island last year from roots given to me by an old negro (John Huggins) who lives near here. He grows a few every year just for his own use, and has grown them from time immemorial." (*Tull.*)

17988. ARACHIS HYPOGAEA. **Peanut.**

From Yungas Valley, Bolivia. Received through Mr. Arthur L. Jackson, of La Paz, Bolivia, March 12, 1906.

17989. NICOTIANA TOMENTOSA

From Hamburg, Germany. Received through Mr. Albert Schenkel, March, 1906.

17990. CHAMAECYPARIS LAWSONIANA.

From Sacramento, Cal. Presented by Mr. H. A. Alspach. Received March 1, 1906.

This is a native of California and Oregon, where it grows to a height of 200 feet. It is one of the most beautiful conifers, of which about 60 garden forms exist in European nurseries and collections. (For foreign exchange.)

17991. SACCHARUM CILIARE.

From St. Kitts, British West Indies. Presented by Mr. F. R. Shepherd, curator, Botanic Gardens, at the request of Sir Daniel Morris, Commissioner of Agriculture for the West Indies. Received October 27, 1905.

Concerning this plant the following brief notice appeared in the Agricultural News, the fortnightly review of the Imperial Department of Agriculture for the West Indies (Vol. IV, p. 87):

"A number of plants of *Saccharum ciliare* raised from seed received through the Imperial Department of Agriculture from India in May last are growing at the Botanic Station, St. Kitts. These plants, which are now arrowing, appear to withstand drought well, and trials are being made to test their usefulness for fodder purposes. This species may also be suitable for forming ornamental clumps on lawns, similar to pampas grass."

17992. MEDICAGO SATIVA. **Alfalfa.**

From Province of Valencia, Spain. Received through Hon. R. L. Sprague, United States consul, Gibraltar, Spain, March 2, 1906.

"The most vigorous and best quality of alfalfa grown in the Province of Valencia, producing continuous crops the whole year." (*Sprague.*)

17993. PHOENIX DACTYLIFERA. **Date.**

From Nefta, Tunis. Presented by Mr. Louis Grech, through Mr. T. H. Kearney. Received November 1, 1905.

Menakher.

17994. TRITICUM VULGARE. **Wheat.**

From Rieti, Italy. Received through Unione Produttori Grano da Seme, March 14, 1906.

Rieti.

17995. GARCINIA MORELLA. **Gamboge.**

From Kingston, Jamaica, British West Indies. Received through Dr. W. Fawcett, director of Public Gardens, March 15, 1906.

Introduced for the purpose of growing stocks upon which to graft the mangosteen.

17996 to 17998. SECHIUM EDULE. **Chayote.**

From Mayaguez, Porto Rico. Received through the Porto Rico Agricultural Experiment Station, February 5 and April 26, 1906.

Fruit of apparently three varieties, as follows:

17996. White.

17997. Small, green.

17998. Large, green.

17999. TRIFOLIUM INCARNATUM. **Crimson clover.**

From Richmond, Va. Received through T. W. Wood & Sons, March 17, 1906.

Late White.

18000. LOLIUM ITALICUM. **Italian rye-grass.**

From New York City, N. Y. Received through Henry Nungesser & Co., March 17, 1906.

18001 to 18118. TRIFOLIUM PRATENSE. **Red clover.**

Received through Mr. Charles J. Brand of this Department and distributed by him in connection with his work on life history, seed production, and change of seed. A series of red clovers of different regional origin, being the first generation from seed of the crop of 1903 which was sown in 1904 and harvested in 1905.

18001 to 18021.

From Shirley, Ill. Received through Mr. Eugene D. Funk, March, 1906.

18022 to 18037.

From Rushville, Ind. Received through Mr. Theodore H. Reed, March, 1906.

18038 to 18054.

From Fayetteville, N. Y. Received through Mr. A. T. Armstrong, March, 1906.

18055 to 18068.

From Manston, Wis. Received through Mr. J. B. McNown, March, 1906.

18069 to 18082.

From Wapakoneta, Ohio. Received through Mr. John A. Ritchie, March, 1906.

18083 to 18100.

From Fargo, N. Dak. Received through Prof. J. H. Shepperd, March, 1906.

18101 to 18118.

From Carlton, Oreg. Received through Mr. F. J. Canfield, April 21, 1906.

18119. BETA VULGARIS. **Sugar beet.**

From Aschersleben, Germany. Received through the Owosso Sugar Company, Owosso, Mich., March 17, 1906.

Jaensch Victrix. Grown by Mr. Gustav Jaensch.

18120. PERSEA GRATISSIMA. **Avocado.**

From Bayamon, P. R. Presented by Mr. A. B. Mitchell. Received March 19, 1906.

Mitchell. "A very superior variety. Size, large; color of flesh, dark yellow; flavor, excellent. Base, usually slender. Seed, medium to large." (*Barrett.*)

18121. CUCURBITA PEPO. **Pumpkin.**

From Australia. Presented by Mr. M. Levek, of Washington, D. C. Received March 18, 1906.

Thought by Mr. Levek to be a variety known as *Turk's Crown.*

18122. RICINUS COMMUNIS. **Castor-oil plant.**

From Santiago de las Vegas, Cuba. Received through Prof. C. F. Baker, March 19, 1906.

A large-seeded variety.

18123 to 18130.

From Bathurst, New South Wales. Presented by Prof. R. W. Peacock. Received February 13, 1906.

Samples of various native grass seeds, as follows:

18123. Eragrostis pilosa.
18124. Eleusine aegyptiaca.
18125. Diplachne fusca.
18126. Diplachne peacockii.
18127. Panicum flavidum.
18128. Panicum prolutum.
18129. Panicum decompositum.
18130. Andropogon sericeus.

18131 to 18151.

From Berkeley, Cal. Received through Prof. A. V. Stubenrauch, of the Agricultural Experiment Station, March 6, 1906.

18131. Vicia nissoliana:
18132. Vicia atropurpurea.
18133. Vicia varia.
18134. Vicia sativa obovata.
18135. Vicia pannonica.
18136. Vicia lutea.
18137. Vicia faba. **Horse bean.**

Black Spanish.

18138. Vicia sativa macrocarpa.
18139. Vicia monanthos.
18140. Vicia monanthos.
18141. Vicia calcarata.
18142. Vicia faba. **Horse bean.**
18143. Vicia faba. **Horse bean.**

Winter.

18144. Lathyrus tingitanus uniflorus.
18145. Lathyrus tingitanus.
18146. Lathyrus clymenum.
18147. Lathyrus annuus.
18148. Lathyrus ochrus.
18149. Lathyrus articulatus.
18150. Lens nigricans.
18151. Trigonella corniculata.

18152 to 18155. Chætochloa italica. **Millet.**

From Lawrence, Kans. Received through F. Barteldes & Co., March 20, 1906.

18152. *New Siberian.*
18153. *Hungarian.*
18154. *German.*
18155. Common.

18156. Ricinus communis. **Castor-oil plant.**

From Santiago de las Vegas, Cuba. Received through Prof. C. F. Baker, March 20, 1906.

A small-seeded variety.

18157. PISUM SATIVUM. **Pea.**

From Paris, France. Received through Vilmorin-Andrieux & Co., March 20, 1906.

Wax-pod.

18158 and 18159.

From Lausanne, Switzerland. Received through Prof. G. Martinet, March 21, 1906.

18158. LATHYRUS HETEROPHYLLUS.

18159. VICIA VILLOSA GLABRESCENS.

18160 to 18198. ANDROPOGON SORGHUM. **Sorghum.**

From Berlin, Germany. Presented by the Berlin Botanical Museum. Received February 14, 1906.

A collection of African sorghum seed, as follows:

18160. *Amphibolus.*
18161. *Calcareus.*
18162. *Charisianus.*
18163. *Charisianus glabrescens.*
18164. *Charisianus holstii.*
18165. *Colorans.*
18166. *Colorans.*
18167. *Colorans.*
18168. *Elegans.*
18169. *Elegans.*
18170. *Elegans.*
18171. *Inhonestus.*
18172. *Kerstingianus typicus.*
18173. *Kerstingianus typicus.*
18174. *Kerstingianus sulfureus.*
18175. *Kerstingianus sulfureus.*
18176. *Kerstingianus sulfureus.*
18177. *Kerstingianus sulfureus.*
18178. *Nitens.*
18179. *Ondongae.*
18180. *Ovulifer.*
18181. *Ovulifer.*
18182. *Ovulifer.*
18183. *Ovulifer.*
18184. *Ovulifer.*
18185. *Ovulifer.*
18186. *Ovulifer.*
18187. *Ovulifer.*
18188. *Ovulifer.*
18189. *Ovulifer.*
18190. *Ovulifer.*
18191. *Pendulus.*
18192. *Roxburghii.*
18193. *Schumannii.*
18194. *Usaramensis.*
18195. *Ziegleri.*
18196. *Elegans.*
18197. *Ovulifer.*
18198. *Ovulifer.*

18199. ELAEAGNUS hyb.

From Gotha, Fla. Received through Mr. Henry Nehrling, March 22, 1906.

18200 and 18201. ZEA MAYS. **Sweet corn.**

From North Pomfret, Vt. Received through Mr. Stephen Hewitt, March 23, 1906.

Golden Malakhor. Grown from S. P. I. No. 13256.

18200.

Amber-colored ears showing a distinct red striping; originally grown from one ear which was dark colored and very sweet.

18201.

Light amber-colored ears; sweet.

18202. VICIA FULGENS. **Scarlet vetch.**

From Paris, France. Received through Vilmorin-Andrieux & Co., March 23, 1906.

18203. ANDROPOGON SORGHUM. **Sorghum.**

From Dallas, Tex. Received through the Texas Seed and Floral Company, March 23, 1906.

Sumac Cane.

18204 to 18224. XANTHOSOMA spp. **Yautia.**

From Mayaguez, P. R. Received through the Porto Rico Agricultural Experiment Station, March 24, 1906.

A collection of yautia roots, as follows:

18204. *Rollisa.*
18205. *Punzera.*
18206. *Gris Amarilla.*
18207. *Jamaica No. 1.*
18208. *Jamaica No. 3.*
18209. *Jamaica No. 5.*
18210. *Dominica.*
18211. *Blanca.*
18212. *Prieta.*
18213. *Amarilla.*
18214. *Guayamera.*
18215. *Alocasia Marchallu.*
18216. *Jamaica No. 2.*
18217. *Jamaica No. 4.*
18218. *Jamaica No. 6.*
18219. *Islena* (Ponce).
18220. *Gengibrilla.*
18221. *Islena* (Aponte).
18222. *Orqueta.*
18223. *Rollisa Ancha.*
18224. *Jamaica* (Trinidad).

18225. ASPARAGUS ACUTIFOLIUS.

From San Giovanni a Teduccio, Italy. Received through Dammann & Co., March 26, 1906.

Roots imported for use in experiments to create a new hybrid asparagus which will resist the asparagus rust.

18226. HOSACKIA PURSHIANA. **Dakota vetch.**

From Dickinson, Dak. Received through the Dickinson Subexperiment Station, March 26, 1906.

18227. GLYCINE HISPIDA. **Soy bean.**

From Khabarovsk, East Siberia. Received through Director Gagin of the Khabarovsk Experiment Field, March 26, 1906.

Tchernie bobi. "A black variety of *Soja hispida*, which is cultivated in several places in Manchuria and Amur land." (*Gagin.*)

18228. PUERARIA THUNBERGIANA. **Kudzu.**

From Philadelphia, Pa. Received through H. A. Dreer (Incorporated), March 27, 1906.

(See Nos. 9227 and 9228, Inventory No. 9.)

18229. AVENA SATIVA. **Oat.**

From Augusta, Ga. Received through the N. L. Willet Drug Company, February 1, 1906.

Appler Rustproof. Special selection of seed from No. 17452.

18230. AVENA SATIVA. **Oat.**

From Richmond, Va. Received through T. W. Wood & Sons, January 27, 1906.

Burt. Special selection of seed from No. 17451.

18231. SECHIUM EDULE. **Chayote.**

From New Orleans, La. Received through the J. Steckler Seed Company, March, 1906.

18232. CUCUMIS MELO. **Winter muskmelon.**

From Ispahan, Persia. Received through Mr. Frank Benton (No. 33), March 27, 1906.

"Seed of a winter muskmelon grown extensively about Ispahan, Persia. It keeps, if put in a cool, airy place, all winter, and may be used at any time. Bears transportation well; many are taken over rough roads on pack animals two to three hundred miles. Oblong, light yellow, netted finely; flesh light yellow, semitransparent or watery; quite juicy; fair quality. Said to succeed best on slightly alkaline soil." (*Benton.*)

18233. BETA VULGARIS. **Sugar beet.**

From Wellsboro, Ind. Received through the West Michigan Sugar Company, March 27, 1906.

Knauer's Mangold.

18234 and 18235. AMYGDALUS spp.

From Quetta, British India. Presented by Lieut. W. L. Maxwell, One Hundred and Twenty-Seventh Baluchistan Light Infantry. Received March 24, 1906.

18234. AMYGDALUS PERSICA. **Peach.**

Quetta.

18235. AMYGDALUS PERSICA LAEVIS. **Nectarine.**

Quetta.

"These seeds were taken from the best trees in Quetta. Quetta is nearly 6,000 feet high; summer temperature, 100° F. in the shade at times; winter temperature known to drop below zero, and severe frost is known to continue for weeks at a time." (*Maxwell.*)

18236 and 18237. CHENOPODIUM QUINOA. **Quinoa.**

From La Paz, Bolivia. Received through Señor M. V. Ballovian, Ministerio de Colonias y Agricultura, March 24, 1906.

18236. CHENOPODIUM QUINOA. **Quinoa.**

Quinoa amarga or *Common.*

18237. CHENOPODIUM QUINOA. **Quinoa.**

Arrocillo or *Royal.*

(See Nos. 2931, 3073, and 3074, Inventory No. 7.)

18238 to 18240.

From Chaman, Baluchistan. Presented by Lieut. W. L. Maxwell, One Hundred and Twenty-Seventh Baluchistan Light Infantry. Received March 29, 1906.

Plants and cuttings, as follows:

18238. AMYGDALUS COMMUNIS. **Almond.**

18239. AMYGDALUS PERSICA. **Peach.**

18240. PUNICA GRANATUM. **Pomegranate.**

18241. VICIA FABA. **Broad bean.**

From Buenos Ayres, Argentina. Presented by Mr. H. B. Vannote, 11 and 13 Vandewater street, New York, N. Y. Received March 26, 1906.

18242 and 18243. PRUNUS spp. **Cherry.**

From Dreshertown, Pa. Received through Thomas Meehan & Sons, March 31, 1906.

Trees to be used as stocks upon which to bud Japanese flowering cherries, as follows:

18242. PRUNUS AVIUM. **Mazzard cherry.**

18243. PRUNUS MAHALEB. **Mahaleb cherry.**

18244. AGAVE RIGIDA SISALANA. **Sisal.**

From Miami, Fla. Collected by Mr. L. H. Dewey, March 8 and 14, 1906. Received March 31, 1906.

Bulbils secured for introduction into Porto Rico.

18245 and 18246. AVENA SATIVA. **Oat.**

From Örebro, Sweden. Received through C. A. Hagendahl's Son, March 28, 1906.

18245. *White.* **18246.** *Black.*

18247. MEDICAGO SATIVA. **Alfalfa.**

From Milwaukee, Wis. Received through the Wernich Seed Company, March 29, 1906.

Turkestan.

18248 to 18255. SOLANUM TUBEROSUM. **Potato.**

From La Paz, Bolivia. Received through Señor M. V. Ballovian, Ministerio de Colonias y Agricultura, March 24, 1906.

18248. *Ymilla.* Raised in La Paz.

18249. *Sicha.* Raised at the foot of the Sub-Andine chains.

18250. *Phureja.* Raised on the table-lands.

18251. *Luqui.* Raised on the table-lands.

18252. *Queni.* Raised in La Paz.

18253. *Apharu.* Raised on the table-land of Bolivia.

18254. *Monda.* Raised on the table-lands.

18255. *Khati.* Raised in La Paz.

18256 to 18277.

From Peking, China. Received at the Plant Introduction Gardens, Chico, Cal., through Mr. F. N. Meyer, February 26 and 27, 1906.

Seeds and cuttings of Chinese plants, the seeds indicated by the letter "a" following the number, as follows:

18256. JUGLANS REGIA. **Persian walnut.**

From Peking. "(No. 3a.) A very large, hard-shelled variety said to have come from the western mountains, where it gets quite cold." (*Meyer.*)

18257. JUGLANS REGIA. **Persian walnut.**

From Peking. "(No. 4a.) A hard-shelled, sweet variety said to have come from the mountains 40 miles north of Peking; will probably prove hardy quite far north." (*Meyer.*)

18256 to 18277—Continued.

18258. GLYCINE HISPIDA. **Soy bean.**

From Pee-san. "(No. 5a.) This soy bean is extensively cultivated in the mountains north of Peking and is highly esteemed for human food; requires but little irrigation, and is well worth trying in the arid West." (*Meyer.*)

18259. GLYCINE HISPIDA. **Soy bean.**

From Tschang-ping-tsu. "(No. 6a.) This bean is grown in the northern country as a nitrogen-supplying crop with sorghum, corn, or millet; does not scatter much when ripe, but seems to be late in ripening." (*Meyer.*)

18260. PRUNUS ARMENIACA. **Apricot.**

From Peking. "(No. 7a.) The so-called Chinese almond, but it is really a sweet-kerneled apricot. It is considered a fine little nut by the Chinese, who eat them salted after having them soaked in water to get rid of the skin." (*Meyer.*)

18261. PRUNUS ARMENIACA. **Apricot.**

From Peking. "(No. 8a.) The same as No. 7a (S. P. I. No. 18260), but inferior in quality; both are probably the same plant. They are said to be a special strain of apricots, being grown only for their seeds." (*Meyer.*)

18262. AMYGDALUS PERSICA. **Peach.**

From Peking. "(No. 9a.) Seeds collected from a tree growing in the German Legation grounds at Peking. This tree, which is about 40 feet high, is a most heavy bearer and looks like a remarkably thrifty peach tree. Its leaves are much darker green than those of the cultivated ones. I was told that it is a fine ornamental tree in the spring, being one sheet of rose-colored blossoms" (*Meyer.*)

18263. JUGLANS REGIA. **Persian walnut.**

From Tientsin. "(No. 10a.) A small variety bought in Tientsin. May prove to be very hardy, as the nuts are small and hard." (*Meyer.*)

18264. XANTHOCERAS SORBIFOLIA.

From Wei-tsan Mountains. "(No. 11a.) A small ornamental tree belonging to the horse-chestnut family. Is very well fit for a solitary lawn tree in a small garden, as it grows only to a small size and makes a dense head of foliage." (*Meyer.*)

18265. QUERCUS DENTATA. **Oak.**

From Ming Tombs, north of Peking. "(No. 12a.) This oak attains a medium size, has very large, dark green leaves, and is well worth growing; looks quite different from other oaks. Collected on the grounds of the Ming Tombs, 30 miles north of Peking, where it gets extremely cold. The trees will probably prove hardy quite far north." (*Meyer.*)

18266. DIOSPYROS LOTUS. **Persimmon.**

From Pee-san. "(No. 13a.) A small persimmon used as stock for the seedless one." (*Meyer.*)

18267. CATALPA BUNGEI. **Catalpa.**

From Wei-tsan Mountains. "(No. 78.) Young trees of which the parents have grown to a very large size in an old temple garden. This tree is one of the finest flowering trees in the world." (*Meyer.*)

18268. TAMARIX sp.

From Wei-tsan Mountains. "(No. 83.) A very graceful bush, suitable for planting along the water's edge." (*Meyer.*)

18269. POPULUS sp. **Poplar.**

From Wei-tsan Mountains. "(No. 84.) This poplar is often found growing in old temple gardens; it has whitish bark and attains a very large size. Probably the same as No. 15 (S. P. I. No. 16915.)" (*Meyer.*)

18256 to 18277—Continued.

18270. JASMINUM NUDIFLORUM. **Jasmine.**

From Wei-tsan Mountains. "(No. 85.) A jasmine with green stems and yellow flowers, adapted for terraces and walls." (*Meyer.*)

18271. LYCIUM sp. **Matrimony vine.**

From Palitswang. "(No. 86.) A matrimony vine which is trained on one stem with all the small branches drooping down like a weeping tree; is loaded in the fall with red berries." (*Meyer.*)

18272. PISTACIA CHINENSIS. **Pistache.**

From Wei-tsan Mountains. "(No. 89.) The carpellate form of the Chinese pistache. A rather ornamental, small tree; bears heavy bunches of small, scarlet-purplish-colored berries." (*Meyer.*)

18273. PISTACIA CHINENSIS. **Pistache.**

From Wei-tsan Mountains. "(No. 90.) The staminate form of the Chinese pistache. A very ornamental tree with graceful, pinnate foliage; grows to very large dimensions." (*Meyer.*)

18274. POPULUS sp. **Poplar.**

From the mountains near Fangshan. "(No. 134.) A poplar found growing in a ravine; probably a tall-growing variety." (*Meyer.*)

18275. MORUS ALBA. **Mulberry.**

From the mountains near Fangshan. "(No. 135.) Tall sprouts found growing by the roadside; may be a new kind." (*Meyer.*)

18276. (Undetermined.)

From the mountains near Fangshan. "(No. 136.) Cuttings of a semi-climbing, low shrub." (*Meyer.*)

18277. KOELREUTERIA PANICULATA. **Varnish tree.**

From Wei-tsan Mountains. (No. 137.)

18278 to 18293.

From Peking, China. Collected by Mr. F. N. Meyer and sent direct to the Arnold Arboretum, Jamaica Plains, Mass. Received during the winter of 1905–6.

Cuttings of Chinese plants, as follows:

18278. EUONYMUS sp.

From Shan-hai-kwan. "(No. 4.) A low-growing shrub with corky wings on its branches; found in semishady situations." (*Meyer.*)

18279. (Undetermined.)

From Shan-hai-kwan. "(No. 16.) A low, spreading bush with edible red berries; grows between rocks and in sunny as well as shady situations." (*Meyer.*)

18280. AMPELOPSIS sp.

From Shan-hai-kwan. (No. 17.)

18281. AMPELOPSIS sp.

From Chang-li. (No. 18.)

18282. PRUNUS sp.

From Shan-hai-kwan. (No. 51.)

18283. SPIRAEA sp.

From Shan-hai-kwan. "(No. 20.) A small, shrubby *Spiraea* resembling *S. thunbergii;* found growing between rocks and exposed places." (*Meyer.*)

18284. AMPELOPSIS sp.

From Chang-li. (No. 21.)

18278 to 18293—Continued.

18285. ACTINIDIA sp. (?)

From Hwai-jou. (No. 22.)

18286. EUONYMUS sp.

From Hwai-jou. "(No. 24.) A very striking *Euonymus* with red leaf tops, resembling *E. bungeanus* but bearing a much larger quantity of fruit." (*Meyer.*)

18287 to 18289. (Undetermined.)

From Shan-hai-kwan. (Nos. 52 to 54.) Cuttings of unidentified shrubs.

18290. PRUNUS ARMENIACA. **Apricot.**

From Shan-hai-kwan. "(No. 55.) A wild apricot growing in a ravine near an old temple." (*Meyer.*)

18291. SPIRAEA sp. (?)

From Shan-hai-kwan. "(No. 56.) Found growing between the rocks in the mountains near Shan-hai-kwan." (*Meyer.*)

18292. AMPELOPSIS sp.

From Chang-li. "(No. 99.) A vine growing on rocky places in the mountains; has deeply lobed leaves and white berries." (*Meyer.*)

18293. AMPELOPSIS sp.

From Chang-li. "(No. 100.) A vine resembling *A. vetchii*, but with both entire and three-lobed leaves; assumes beautiful fall colors and though small and apparently tender is well worth trying." (*Meyer.*)

18294 to 18296.

From Peradeniya, Ceylon. Received through J. C. Willis, director of Royal Botanic Gardens, February 26, 1906.

18294. CROTALARIA sp.

Imported for experimental purposes in connection with cover crops for tea and coffee plantations.

18295 and 18296. ARACHIS HYPOGAEA. **Peanut.**

18295. *Mauritius.* **18296.** (Unnamed.)

18297 and 18298. IPOMOEA BATATAS. **Sweet potato.**

From Kingston, Jamaica, British West Indies. Presented by Dr. William Fawcett, director of Hope Gardens. Received March 29, 1906.

"Tubers of the two varieties of white-skinned potato which thrive best here." (*Fawcett.*)

18297. *John Barnett.* **18298.** *Law.*

18299. HUMULUS LUPULUS. **Hop.**

From North Yakima, Wash. Presented by Mr. H. B. Scudder. Received February, 1906.

Semsch. Seeds produced on vine of S. P. I. No. 5787, in 1905. "Probably these seeds were results of pollination with pollen from the male plants of the common Yakima hop. They should be planted for selection of the best seedlings." (*Fairchild.*)

18300 and 18301. CANNA spp. **Canna.**

From Palermo, Sicily. Presented by Prof. Dr. A. Borzi, director of the Botanic Gardens. Received March 30, 1906.

18300. CANNA INDICA. **18301.** CANNA IRIDIFLORA.

18302. ZEA MAYS. **Corn.**

From Callao, Peru. Presented by Mr. C. B. Cisneros. Received March 12, 1906.

18303 to 18309.

From Teheran, Persia. Presented by Mr. John Tyler, United States vice-consul-general. Received March 23, 1906.

Seeds, as follows:

18303. CUCUMIS MELO. **Muskmelon.**

A white-skinned variety.

18304. CUCUMIS MELO. **Muskmelon.**

Kharbuzzah. "This is thought to be a corruption of *khar poozah*, khar meaning ass and poozah snout or nose, possibly on account of its oblong shape. The highest quality of this kind is produced at a village 16 miles north of Ispahan, called Gurg Ab (Wolf Water), being irrigated with water impregnated with alkaline elements. The flavor is agreeably sweet and pleasant, and approved by almost every individual taste. When ripe, however, on account of the delicacy of the texture of the skin and the crispness of the inner substance it can not be transported without damage from the place where it is grown. It is said that the vibration caused to the ground by a horse cantering within a few yards will split it up, and that to pierce it with a pin is sufficient to make a circle of cracks. Such as are brought to Teheran, and those taken to towns nearer the area of growth, are cut before they are ripe and consequently lose much of their delicacy of flavor. The principal supply for the Teheran market is produced from 12 to 30 miles away, and the fruits are of various qualities, according to the soil and water supply. None are grown in the immediate vicinity of the city. The color of the *Kharbuzzah* in the best qualities is a pale yellow, but there are some nearly white or of a cream color." (*Tyler.*)

18305. CUCUMIS MELO. **Muskmelon.**

Tálabee (Desired). "In shape a spheroid, of a greenish tinge both inside and out, although some are inclined to yellow. When good, their flavor is pleasant and rather sweet. If, however, they are deficient in sweetness, sugar may be added with advantage. In this they differ from the *Kharbuzzah*, which is not improved by sugar; in fact, many people eat it with pepper and salt. Their average weight is from 4 to 5 pounds, and I do not think that I have ever seen one that exceeded a batman (6½ pounds)." (*Tyler.*)

18306. CUCUMIS MELO. **Muskmelon.**

Garmack (Little heat). "This variety resembles in shape, size, and flavor, though not so sweet, the *Tálabee*. It is less delicate in texture, and if of a poor quality is not much better than a Swede turnip; but as it is the first to come to market it finds considerable favor. If, however, it lacks sweetness its flavor coalesces very well with pounded sugar." (*Tyler.*)

18307. CUCUMIS SATIVUS. **Cucumber.**

Persian Khear. "A smooth-skinned variety about 5 or 6 inches in length, and the larger 6 or 7 inches in circumference. They are crisp in texture and pleasant to the taste. I think they are a little sweeter than ours, and consequently preferred by the natives. These plants, both melons and cucumbers, are planted on the margin of a trench with a bank about 4 feet wide when quite dry for the plant to lie upon, for if the fruit comes in touch with the irrigation water it brings on the rot." (*Tyler.*)

18308. CITRULLUS VULGARIS. **Watermelon.**

Andarânah. "Probably a corruption of *Hind-daneh*, meaning Indian grain or seed, partially confirming the common belief that it was originally brought from India, although it has been extensively cultivated in Persia for centuries. In some districts of eastern Persia it attains an immense size, weighing upward of 100 pounds, but in Teheran it rarely exceeds a third of that weight. Being very cheap in price, it is looked upon as a generous addition to the diet of the poor." (*Tyler.*)

18303 to 18309—Continued.

18309. ANDROPOGON SORGHUM. **Sorghum.**

(No data.)

18310. PHASEOLUS MAX. **Mung bean.**

From Barbados, British West Indies. Presented by Hon. D. Morris, Commissioner of Agriculture for the West Indies. Received April 6, 1906.

Woolly Pyrol.

18311 to 18315. ARACHIS HYPOGAEA. **Peanut.**

From Peradeniya, Ceylon. Presented by Mr. J. C. Willis, director of Royal Botanic Gardens. Received April 6, 1906.

18311. *Tanjore.*

18312. *Mauritius.*

18313. *Pondicherry.*

18314. *Barbados.*

18315. *Brazil.*

18316 to 18318. DIOSCOREA spp. **Yam.**

From Mayaguez, P. R. Presented by the Agricultural Experiment Station. Received April 4, 1906.

18316. DIOSCOREA ACULEATA GUINEA.

18317. DIOSCOREA TRIFIDA.

A white variety.

18318. DIOSCOREA TRIFIDA.

A purple variety.

18319 and 18320.

From Manila, P. I. Presented by Mr. William S. Lyon, horticulturist, Bureau of Agriculture. Received April 3, 1906.

18319. XANTHOSOMA sp. **Yautia.**

"Locally known as *Gabe de China*. Chief distinction seems to be in the size of the main rootstock, which grows very large. Grown alongside of introduced *Xanthosoma*, it made in eight months a main rootstock as large and half again, weighing, when green, nearly 2 pounds." (*Lyon.*)

18320. COLOCASIA sp.

Most common *Gabe* of the Philippine Islands.

18321. CANAVALIA ENSIFORMIS. **Sword bean.**

From Mayaguez, P. R. Presented by the Agricultural Experiment Station. Received March 27, 1906.

18322 and 18323. SACCHARUM OFFICINARUM. **Sugar cane.**

From Cienfuegos, Cuba. Presented by Dr. Robert M. Grey, Harvard Botanical Station, Central Soledad. Received March 27, 1906.

Samples of each of the following hand-fertilized sugar cane seed:

18322. *Crystallina* × *Crystallina.*

18323. *Crystallina* (female) × *Java seedling No. 51* (male).

18324. LILIUM PHILIPPINENSE. **Lily.**

From Thetford, Vt. Received through Mr. George S. Worcester, April 10, 1906.

18325. PELTANDRA SAGITTAEFOLIA. **Wampee.**

From Cat Island, South Carolina. Received through Mr. John Tull, April 9, 1906.

"The roots are extensively eaten by the colored natives." (*Tull.*)

18326. ANDROPOGON SORGHUM. **Sorghum.**

From Bombay Presidency, India. Presented by Prof. G. A. Gammie, economic botanist, Ganeshkhind Botanical Gardens, Kirkee, Poona, India. Received April 9, 1906.

"Seed of a dwarf variety of sorghum cultivated in the Punch Mahals District of the Bombay Presidency. It is locally known by the name of *Rátáila* and grows to the height of 2½ to 3½ feet." (*Gammie.*)

18327. POA TRIVIALIS. **Rough-stalked meadow grass.**

From Paris, France. Received through Vilmorin-Andrieux & Co., April 7, 1906.

18328. CUCURBITA MELANOSPERMA. **Ecuador melon.**

From Quito, Ecuador. Presented by Mr. S. Ordonez M. Received April 9, 1906.

"This plant is native to this country, where it is cultivated quite extensively and used for food for man as well as for stock. Although a perennial, it is more commonly treated as an annual and planted with corn. It is also planted along walls and at the foot of trees, upon which it will climb and produce melons continuously. The plant will not endure severe frost, and grows where the temperature ranges from 14° to 25° C.

"When used as human food the melon, as long as it is so soft that a finger nail can be driven into the shell, is simply cooked and made into different dishes with butter and salt; when ripe it is eaten cooked, with milk added at the table. For stock it is used ripe and simply cut to pieces; when cooked, however, it is far better, especially for stock and milch cows.

"The melons average 20 to 30 pounds each. The pulp is white and contains sugar and some starch. When completely ripe the shell is very hard and the seeds black, giving the melons much the appearance of a watermelon. The ripe melons can easily be kept a year in a dry and ventilated place, this condition making them valuable for winter feed. There are two varieties—the white-shelled and the green and white striped. These seeds are of the latter variety." (*S. Ordonez M.*)

18329 to 18331.

From Manila, P. I. Presented by Mr. William S. Lyon, horticulturist, Bureau of Agriculture. Received April 3, 1906.

18329. CANAVALIA ENSIFORMIS. **Knife bean.**

"'*Marautong*' of the Pampangans. The young and tender pods make an excellent snap bean, and the green as well as the fully ripe seeds are a good substitute for Lima or Haricot beans. This variety, while prostrate and rambling, is distinctively nontwining. It makes pods in two months and matures seeds in four months from planting." (*Lyon.*)

18330. CROTALARIA JUNCEA. **Sunn hemp.**

"This requires rich soil, abundant moisture, and close planting to produce long fiber. If planted wide and kept pinched it becomes very floriferous and an ornamental acquisition to the garden." (*Lyon.*)

18331. PACHYRHIZUS ANGULATUS. **Yam bean.**

18332. BETA VULGARIS. **Sugar beet.**

From Raunitz, near Wettin, Germany. Received from Mr. G. Wesche, through Mr. E. Nettwall, of Prague, Bohemia, April 11, 1906.

Wesche's Ertragreichste, or *Richest in Yield.*

18333. EUTREMA WASABI. **Japanese horse-radish.**

From Yokohama, Japan. Received through the Yokohama Nursery Company, April 11, 1906.

(For description see No. 9891, Inventory No. 10.)

18334 to 18337. ARACHIS HYPOGAEA. **Peanut.**

From Suffolk, Va. Received through the Suffolk Peanut Company, April 13, 1906.

A collection of peanuts obtained for foreign exchange, as follows:

18334. *Virginia.*
18335. *Bunch.*
18336. *Carolina.*
18337. *Spanish.*

18338. VICIA SATIVA. **Common vetch.**

From Svalöf, Sweden. Received through Allmänna Svenska Utsädesaktiebolaget, April 13, 1906.

18339. HEDYSARUM SIBIRICUM.

From Groningen, Holland. Presented by the Jardin Botanique de Groningen. Received April 12, 1906.

18340. VICIA FABA. **Broad bean.**

From London, England. Presented by Mr. S. E. Wynne. Received April 14, 1906.

Harlington White Windsor. "To grow: Plant in good, strong, rich soil in January or February for main crop, and from February to May for successive crops. Plant in rows 2 feet to 30 inches apart; when the plants are about 30 inches high cut off the tops; they need no staking. Gather the pods when young, when the seeds are not over three-fourths inch in length.

"To cook: Use plenty of water, adding a heaped tablespoonful of salt to each half gallon. Shell the beans, put them into boiling water, and boil rapidly until tender—about fifteen minutes for very young beans. Drain them thoroughly, and serve quite separately, but with a sauceboat of parsley sauce as an accompaniment. The beans are excellent with boiled bacon, but they must be cooked alone, never with the meat. If very young they should be cooked fifteen minutes; if older, twenty to twenty-five minutes, but do not overcook them. Half a peck of the pods should yield a good dish. In England they are in season in July and August.

"Average cost, 6s. per peck." (*Wynne.*)

18341. CASTANEA SATIVA. **Chestnut.**

From Yokohama, Japan. Received through the Yokohama Nursery Company, April 14, 1906.

18342. SOLANUM JAMESII.

From Grand Island, Nebr. Presented by Mr. E. Corbin. Received April 17, 1906.

(See No. 10473, Inventory No. 11.)

18343 to 18345. ANDROPOGON SORGHUM.

From Lawrence, Kans. Received through F. Barteldes & Co., April 17, 1906.

18343. *Jerusalem corn* sorghum.
18344. *Red* kafir corn.
18345. *Yellow* milo.

18346 to 18357.

From Gatton, Queensland, Australia. Presented by Prof. John Mahon, principal of the Queensland Agricultural College. Received April 18, 1906.

18346. Andropogon sericeus.
18347. Andropogon intermedius.
18348. Anthistiria ciliata.
18349. Chloris divaricata.
18350. Chloris truncata.
18351. Chrysopogon parviflora.
18352. Eragrostis brownei.
18353. Eriochloa punctata.
18354. Ischaemum pectinatum.
18355. Panicum decompositum.
18356. Panicum divaricatissimum.
18357. Andropogon australis.

18358 to 18381.

From Hanatote, Ugo, Japan. Presented by Mr. S. Nakagawa, Riku-u Agricultural Experiment Station. Received April 12, 1906.

Seeds, as follows:

18358. Brachypodium japonicum.
18359. Brachypodium japonicum.
18360. Bromus unioloides.
18361. Cassia mimosoides.
18362. Coix lacryma-jobi.
18363. Desmodium gardneri.
18364. Eleusine coracana.
18365. Eragrostis ferruginea.
18366. Eriochloa villosa.
18367. Holcus lanatus.
18368. Indigofera tinctoria.
18369. Lespedeza buergeri.
18370. Lespedeza striata.
18371. Lotus corniculatus japonicus.
18372. Miscanthus sinensis.
18373. Paspalum thunbergii.
18374. Pennisetum japonicum.
18375. Chaetochloa glauca.
18376. Chaetochloa pachystachya.
18377. Chaetochloa viridis.
18378. Chaetochloa viridis gigantea.
18379. Spodiopogon cotulifer.
18380. Vicia amoena lanata.
18381. Vicia unijuga.

18382. Macadamia ternifolia. Queensland nut.

From Brisbane, Queensland, Australia. Presented by Prof. F. Manson Bailey. Received April 18, 1906.

"The Queensland nut is well worthy of cultivation in Ceylon, not only as an ornamental or windbelt tree, but also for its dainty product. That it is suited to our climate may be judged from the growth of the tree at Peradeniya, where, having been introduced in 1868, it is now 40 to 50 feet high, with a spreading habit. It is indigenous to the northeastern parts of Australia, and is commonly known there as the 'Queensland nut.' It has also been referred to as the 'Australian hazelnut,' while the late Baron von Mueller described it as 'the nut tree of subtropical eastern Australia.' The tree is at first of a rather slow-growing habit, but begins to bear fruit when 6 or 7 years old, increasing in fertility until it reaches the age of 15 years.

"A writer in the Sydney Mail some time ago stated that the tree fruited freely from the time it was 8 years old, bearing at the age of 13 1,200 nuts, with which every branch was laden. Mr. W. J. Allen, in the Agricultural Gazette of New South Wales for October of last year, draws attention to the importance of growing the Queensland nut for the market. 'One farmer,' he states, 'has over an acre of these nuts, which are doing well with him and which prove themselves very profitable, finding ready sale for them at from 6d. to 7d. per pound. The nuts are retailed in the Sydney fruit shops at 1s. per pound, and are very well liked when they become known. At present the supply in our own state can not be anything like equal to the demand, and it seems to me that if these nuts were produced in quantities we should be able to find a ready sale for large supplies in Great Britain and America.' Mr. Allen describes the nut as 'one of the best-flavored on the market,' and he would recommend all those who have not tasted them to buy a few and try them.

18382—Continued.

"The nuts are borne on spikes 4 to 7 inches long, each being of the size and shape of large marbles, about three-fourths of an inch in diameter. These have an agreeable flavor, which according to some tastes is richer than that of the hazelnut. Their chief objection is, perhaps, their very hard shell, which requires extra strong nutcrackers to break.

"The tree belongs to the order Proteaceae, to which belongs also the well-known Grevillea or 'Silky Oak.' It is evergreen, with a low, branching habit; thrives best in good damp soil, and is propagated by seed. The leaves are in whorls of 3 (ternate) or 4, as the name indicates, and the flowers are creamy white, in racemes 4 to 6 inches in length, and sweet-scented." (*H. F. Macmillan, in Tropical Agriculturist, Feb., 1906.*)

18383 to 18387.

From Singapore, Straits Settlements. Presented by Prof. Henry N. Ridley, director, Botanical Gardens. Received April 17, 1906.

A collection of aroids, as follows:

18383. ALOCASIA INDICA.

18384. ALOCASIA INDICA.

18385. XANTHOSOMA VIOLACEUM.

18386. AMORPHOPHALLUS SATIVUS.

18387. AMORPHOPHALLUS CAMPANULATUS.

18388 and 18389. ANDROPOGON SORGHUM. **Sorghum.**

From Bassorah, Persian Gulf. Received through Mr. Herbert W. Poulter, April 16, 1906.

18388.

Tappo Dari. "The best quality obtainable; is planted around Bagdad and Amara. The word *Tappo*, specifying a better quality, is Turkish and represents the name of the branch of the court which looks after the collecting of the taxes on the ground. It appears that the *Dari* coming from lands held by the court was better looked after, and so a better quality obtained; hence the name *Tappo*." (*Poulter.*)

18389.

Common Dari. Planted along the Euphrates River.

18390. CYPERUS ESCULENTUS. **Chufa.**

From Valencia, Spain. Received through Hon. Henry A. Johnson, United States consul, April 19, 1906.

18391. MEDICAGO SATIVA. **Alfalfa.**

From Logan, Mont. Received through Mr. Martin Jacoby, April 18, 1906.

Turkestan alfalfa grown in 1905 from No. 9455.

18392. VITIS VINIFERA. **Grape.**

From Salonica, Turkey. Presented by Mr. J. Henry House. Received April 2, 1906.

Cuttings of the long finger grape *Valandova;* much prized for shipping to northern countries from Salonica.

18393. ANTIDESMA BUNIUS.

From Manila, P. I. Presented by Mr. W. S. Lyon, horticulturist of the Manila Bureau of Agriculture. Received April 18, 1906.

"*Bignay* of the Malays. A medium-sized, evergreen tree; highly ornamental in or out of fruit. Fruit (edible) in racemes about the size and color of the large, red *Versailles* currant." (*Lyon.*)

18394. TRIFOLIUM PRATENSE. **Red clover.**

From Riga, Russia. Received through Mr. F. Lassman, April 20, 1906.

18395. CUCURBITA MELANOSPERMA. **Ecuador melon.**

From Quito, Ecuador. Presented by Mr. S. Ordonez M. Received April 21, 1906.

White-shelled variety. (For description see No. 18328.)

18396. PISUM ARVENSE. **Field pea.**

From Ispahan, Persia. Received through Mr. Frank Benton, April 2, 1906.

"No. 34. A clover-like plant grown as a forage crop about Ispahan and known as *Guergueruh*. It is said to be an annual and seems to be used as a winter cover for land, the same as crimson clover in the United States. The plants are quite green in January after numerous frosts." (*Benton.*)

18397. CUCURBITA PEPO. **Pumpkin.**

From Shiraz, Persia. Received through Mr. Frank Benton, April 2, 1906.

"No. 35. A small, long, salmon-colored squash; enlarged at blossom end. The natives praise the quality, but as prepared for me it was watery and of poor flavor." (*Benton.*)

18398. CUCURBITA MAXIMA. **Squash.**

From Shiraz, Persia. Received through Mr. Frank Benton, April 2, 1906.

"No. 36. A medium-sized, oval, slate-colored, hard-skinned squash of indifferent quality on sale in the markets of Shiraz, in February, where seed was taken from a freshly cut specimen. Might be useful for stock. The region about Shiraz is dry and depends upon irrigation; elevation about 5,000 feet." (*Benton.*)

18399. FRAXINUS ORNUS. **Ash.**

From Nizamabad, central Persia. Received through Mr. Frank Benton, April 2, 1906.

"No. 37. Seeds taken from a cultivated ornamental tree growing near a pool of water at Nizamabad." (*Benton.*)

18400. CARICA PAPAYA. **Papaw.**

From Karachi, province of Sind, India. Received through Mr. Frank Benton, April 16, 1906.

"No. 39. Seed of a tree 20 to 30 feet tall, with large leaves, bearing fruits the size of a small muskmelon, greenish yellow outside when ripe; orange-yellow within. Grows commonly in the warmer parts of India." (*Benton.*)

18401. BRASSICA RAPA. **Turnip.**

From Quetta, Baluchistan. Received through Mr. Frank Benton, April 16, 1906.

"(No. 45.) The roots, which grow to considerable size, are flat in form and are bright crimson outside. The flesh is white, firm, and of a good quality." (*Benton.*)

18402. IPOMOEA BATATAS. **Sweet potato.**

From Quetta, Baluchistan. Received through Mr. Frank Benton, April 16, 1906.

"(No. 46.) Large sweet potatoes; red outside and quite sweet. Purchased in the market at Quetta and probably grown in the lowlands of the Indus." (*Benton.*)

18403 to 18407.

From Quetta, Baluchistan. Received through Mr. Frank Benton, April 16, 1906.

Seeds, as follows:

18403. DAUCUS CAROTA. **Carrot.**
(No. 47.)

18404. PINUS GERARDIANA. **Pine.**
(No. 48.)

18405. CUCURBITA MAXIMA. **Squash.**
(No. 49.)

18406. CUCURBITA MAXIMA. **Squash.**
(No. 50.)

18407. VITIS VINIFERA. **Grape.**
(No. 51.)

18408. SECHIUM EDULE. **Chayote.**

From Mayaguez, P. R. Received through the Agricultural Experiment Station, April 26, 1906.

Fruits of a variety of chayote which is covered with spines.

18409 and 18410. SACCHARUM OFFICINARUM. **Sugar cane.**

From Bridgetown, Barbados. Presented by Hon. Sir Daniel Morris, K. C. M. G., Commissioner of Agriculture for the British West Indies. Received April 23, 1906.

18409. *Collynns seedling.* **18410.** *Sealy seedling.*

18411. ANDROPOGON SORGHUM. **Sorghum.**

From Roswell, N. Mex. Received through Mr. G. S. Nutter, April 19, 1906.

African sumac cane.

18412. TRIFOLIUM PRATENSE. **Red clover.**

From Baltimore, Md. Received through W. G. Scarlett & Co., April 23, 1906.

Austrian.

18413 to 18421.

From New York, N. Y. Received through Henry Nungesser & Co., April 23, 1906.

A collection of seeds, as follows:

18413. AGROSTIS CANINA. **Rhode Island bent-grass.**

18414. ALOPECURUS PRATENSIS. **Meadow foxtail.**

18415. ARRHENATHERUM ELATIUS. **Tall meadow oat-grass.**

18416. BROMUS ERECTUS.

18417. FESTUCA ELATIOR. **Tall fescue.**

18418. MEDICAGO SATIVA. **Alfalfa.**
Provence.

18419. POA COMPRESSA. **Canada bluegrass.**

18420. TRIFOLIUM INCARNATUM. **Crimson clover.**

18421. TRIFOLIUM MEDIUM. **Mammoth clover.**

18422. VICIA VILLOSA. **Hairy vetch.**

From New York, N. Y. Received through Henry Nungesser & Co., April 23, 1906.

18423. ECHINACEA HELIANTHI.

From Riverton, N. J. Received through Henry A. Dreer (Incorporated), Philadelphia, Pa., April 23, 1906.

Plants obtained for hybridizing experiments.

18424. CANNA sp. **Canna.**

From Guam. Presented by Mr. H. L. W. Costenoble, superintendent of the Guam Agricultural Experiment Station. Received April 23, 1906.

"Seed of the native Guam canna, which grows to a height of 8 feet and produces blossoms uninterruptedly." (*Costenoble.*)

18425. MEDICAGO SATIVA. **Alfalfa.**

From Marblehead, Mass. Received through J. J. H. Gregory & Son, April 23, 1906.

Turkestan.

18426 and 18427.

From Juarez, Chihuahua, Mexico. Presented by Mr. Elmer Stearns, of the Agricultural College and Station. Received April 25, 1906.

18426. ZEA MAYS. **Corn.**

Flint corn from Budapest.

18427. (Undetermined.) **"Tree pea."**

18428. PASSIFLORA sp.

From Tecalitlan, Jalisco, Mexico. Presented by Mr. C. V. Mead. Received April 20, 1906.

18429 to 18458.

From Shanghai, China. Received through Mr. F. N. Meyer, April 28, 1906.

A miscellaneous collection of plants and seeds, the seeds being indicated by the letter "a" following the numbers, as follows:

18429. JUNCUS sp. **Rush.**

From Soochow. "(No. 521.) A variety of matting rush collected near Soochow. They must be grown in muddy soil with 2 to 3 inches of standing water." (*Meyer.*)

18430. JUNCUS sp. **Rush.**

From Soochow. "(No. 523.) The rush from which pith wicks for the Chinese oil lamps are made." (*Meyer.*)

18431. (Undetermined.) **"Kaba."**

From Soochow. "(No. 525.) A new vegetable, said to be very delicious; must be grown in muddy soil with 3 to 4 inches of water." (*Meyer.*)

18432. GYMNOCLADUS CHINENSIS.

From Hanchau. "(No. 202a.) A tall-growing tree with naked branches, bearing heavy pods, which are used by the Chinese as a substitute for soap. Chinese name *Soa Ache.* The tree may be of use as an ornamental tree in the Southern States." (*Meyer.*)

18433. GYMNOCLADUS CHINENSIS.

From Hanchau. "(No. 203a.) A small-podded soap tree; otherwise the same description applies to it as to No. 18432." (*Meyer.*)

18429 to 18458—Continued.

18434. VICIA FABA. **Broad bean.**

From Shanghai. "(No. 204a.) A variety of broad bean grown as a winter crop on rice fields." (*Meyer.*)

18435. CORCHORUS CAPSULARIS. **Jute.**

From Shanghai. "(No. 210a.) Seeds of the so-called *Mo-hi* fiber." (*Meyer.*)

18436. SAPINDUS UTILIS. **Soapberry.**

From near Hanchau. (No. 211a.)

18437. RAPHANUS SATIVUS. **Radish.**

From Hanchau, "(No. 212a.) A small variety of red radish with round, elongated form. Seeds were obtained through Mr. F. D. Cloud, acting consul at Hanchau." (*Meyer.*)

18438. ASTRAGALUS sp.

From Shanghai. (No. 213a.)

18439. CITRUS MEDICA. **Lemon.**

From Hanchau. "(No. 214a.) A large Chinese lemon, or possibly wild pomelo. A citrus fruit which serves the purpose here of our lemon. The fruit is very large, 4 inches long by 2½ to 3 inches wide; has loose skin which is full of a particularly pungent oil. The trees come true to seed and grow tall; branches are rather bare and full of large spines; can stand severe frosts and heavy snowfalls and may be of use as a stock plant for the northern limit of our citrus belt." (*Meyer.*)

18440. CITRUS DECUMANA. **Pomelo.**

From Shanghai. "(No. 215a.) Seeds of a large, loose-skinned, loosely segmented pomelo, which is eaten here like the orange and is not bitter at all. A fruit well worth introducing." (*Meyer.*)

18441. BRASSICA sp.

From Tang-hse near Hanchau, Che-kiang Province. "(No. 216a.) The plant producing these seeds, out of which a good edible oil is made, is only grown as a winter crop on rice fields, and the crop is ripe before the rice needs the space. The young tops of the plant are eaten boiled as a vegetable." (*Meyer.*)

18442. BRASSICA spp.

From Shanghai. (No. 217a.) Apparently a mixture of at least two varieties of Brassica.

18443. PANICUM MILIACEUM. **Broom-corn millet.**

From Shanghai. (No. 218a.)

18444. PHASEOLUS CALCARATUS. **Bean.**

From Shanghai. "(No. 236a.) A small, reddish bean used as food. Chinese name *Mu tsa.*" (*Meyer.*)

18445. PERILLA OCYMOIDES. **Perilla.**

From Shanghai. (No. 237a.)

18446. NELUMBO NUCIFERA ALBA. **White lotus.**

From Shanghai. "(No. 238a.) The seeds are highly esteemed by the Chinese as delicatessen. They boil them and roll them in powdered sugar, and they taste fine. Our confectioners might try to make the public acquainted with them." (*Meyer.*)

18447. NELUMBO NUCIFERA ROSEA. **Red lotus.**

From Shanghai. "(No. 239a.) Much cheaper than the white variety; otherwise the same description applies to it." (*Meyer.*)

18448. DOLICHOS LABLAB. **Hyacinth bean.**

From Shanghai. (No. 244a.)

18429 to 18458—Continued.

18449. Raphanus sativus. **Radish.**

From Shanghai. "(No. 245a.) Seed of a white variety." (*Meyer.*)

18450. Abutilon avicennae. **China jute.**

From Shanghai. "(No. 246a.) Seed of a fiber-producing plant called *pa-mu.*" (*Meyer.*)

18451. Cannabis sativa. **Hemp.**

From Shanghai. (No. 247a.)

18452. Brassica sp.

From Shanghai. (No. 248a.)

18453. Corchorus sp.

From Shanghai. "(No. 249a.) Seed of a fiber-producing plant called '*Ching-mu-tse.*' The fiber is used in weaving rush mats." (*Meyer.*)

18454. Hordeum vulgare. **Barley.**

From Shanghai. (No. 250a.)

18455. Pisum sativum. **Pea.**

From Shanghai. (No. 251a.)

18456. (Undetermined.)

From Shanghai. (No. 252a.) A mixture of vetches and peas.

18457. Triticum vulgare. **Wheat.**

From Tan-yang. (No. 253a.)

18458. Hordeum vulgare nudum. **Barley.**

From Tan-yang. "(No. 254a.) Seed of a hull-less barley obtained at Tan-yang near Chinkiang, south of the Yangtze River." (*Meyer.*)

18459 and 18460. Glycine hispida. **Soy bean.**

From West Branch, Mich. Received through Mr. Edward E. Evans, May 2, 1906.

18459. *Green.* **18460.** *Early black.*

18461. Trifolium sp. **Clover.**

From Pretoria, Transvaal. Presented by Prof. J. Burtt Davy, agrostologist and botanist of the Transvaal Department of Agriculture. Received April 30, 1906.

"*Limoru* clover seed from British East Africa, where it grows at an altitude of about 6,000 to 7,000 feet; it also appears to grow well when planted in a dry country." (*Davy.*)

18462. Cucumis melo. **Muskmelon.**

From Cartagena, Colombia. Presented by Mr. Wm. R. Maxon, of San Jose, Costa Rica. Received April 28, 1906.

Seed of the native Cartagena muskmelon.

18463. Andropogon cymbarius.

From Central Madagascar. Presented by M. Derlandlee, of the Madagascar Department of Agriculture, Tananarivo. Received April 27, 1906.

"A good forage plant when young, and the best known of the central Madagascar species. Known by the natives as *Verotsanjy.*" (*Derlandlee.*)

18464 to 18467. ASPARAGUS spp. **Asparagus.**

From Palermo, Sicily. Presented by Prof. Dr. A. Borzi, of the Royal Botanical Gardens. Received May 2, 1906.

Asparagus roots and seeds, as follows:

18464. ASPARAGUS ACUTIFOLIUS. (Roots.)

18465. ASPARAGUS ACUTIFOLIUS. (Seeds.)

18466. ASPARAGUS MEDEOLOIDES. (Seeds.)

18467. ASPARAGUS MEDEOLOIDES. (Roots.)

18468. CITRUS TOROSA.

From Manila, P. I. Presented by Mr. William S. Lyon, horticulturist, Bureau of Agriculture. Received May 2, 1906.

18469. LEVISTICUM OFFICINALE. **Lovage.**

From Holland, Mich. Received through Mr. William Kremers, May 3, 1906.

Plants advertised by the Greening Nursery Company, of Monroe, Mich., as the "Silver King Hardy Celery." Obtained for determination.

18470. MEDICAGO MEDIA. **Sand lucern.**

From Milwaukee, Wis. Received through the Wernich Seed Company, May 3, 1906.

18471. HUMULUS LUPULUS. **Hop.**

From Stevens Point, Wis. Received through Mr. A. N. Mueller, April 28, 1906.

Bohemian.

18472 and 18473. VIGNA UNGUICULATA. **Cowpea.**

From Augusta, Ga. Received through the N. L. Willet Seed Company, May 4, 1906.

18472. *Black-eye.*

18473. *Unknown.*

18474. HARPEPHYLLUM CAFFRUM. **Kafir plum.**

From Cape Town, South Africa. Presented by Mr. C. P. Lounsbury, of the Department of Agriculture. Received May 10, 1906.

Seed collected in the Eastern Province of Cape Colony. (For description see No. 9616.)

18475. ABROMA AUGUSTA. **Anabó.**

From Manila, P. I. Presented by Mr. W. S. Lyon, horticulturist, Bureau of Agriculture. Received May 11, 1906.

"A perennial shrub producing the Anabó bast fiber." (*Lyon.*)

18476. SAPINDUS UTILIS. **Soapberry.**

From Algiers, Algeria. Received through Mr. James Johnston, United States consul, April 30, 1906.

"A native of South China, cultivated in Algeria, where it comes into bearing in eight or ten years. The tree prefers dry, rocky soil, and has been known to yield $10 to $20 worth of berries every year. These contain 38 per cent saponin, an alkaline principle which makes them useful for cleaning purposes. In eastern countries the fruit was much used before the introduction of soap and is still preferred for washing the hair and cleansing delicate fabrics like silk." (*Barclay.*)

18477. PANICUM MILIACEUM. **Broom-corn millet.**

From New York, N. Y. Received through J. M. Thorburn & Co., May 2, 1906.

White French.

18478. ASPARAGUS SCABER.

From Frescati, near Stockholm, Sweden. Presented by Prof. Veit Wittrock. Received May 1, 1906.

Seeds obtained for hybridizing work conducted by Mr. G. W. Oliver, of this Department.

18479. GARCINIA MANGOSTANA. **Mangosteen.**

From Buitenzorg, Java. Presented by Doctor Treub, director of the Botanical Gardens. Received May 5, 1906.

18480 to 18498.

From Fürstenalps, near Khur, Switzerland. Presented by Dr. F. G. Stebler, director of the Seed Control Station, Zurich. Received May 4, 1906.

A collection of hardy grass and forage plant seeds raised in Doctor Stebler's alpine garden in the Fürstenalps, near Khur, at an altitude of 5,700 feet. "These are all hardy strains which have been raised for some years in this garden and thoroughly acclimated to a short, cold growing season. That these forms are extremely hardy has been frequently proved by planting commercial seed of the same kind in these gardens, where it is invariably killed out for the most part during the first season." (*Stebler.*)

18480. PÒTERIUM DODECANDRUM.
18481. FESTUCA VIOLACEA.
18482. POA ALPINA.
18483. FESTUCA HALLERI.
18484. ALOPECURUS PRATENSIS.
18485. ARRHENATHERUM ELATIUS.
18486. PHLEUM MICHELII.
18487. FESTUCA PRATENSIS.
18488. POTERIUM OFFICINALE.
18489. LIGUSTICUM MUTELLINA.
18490. FESTUCA PUMILA.
18491. BROMUS INERMIS.
18492. DACTYLIS GLOMERATA.
18493. OXYTROPIS CAMPESTRIS.
18494. PHACA FRIGIDA.
18495. OXYTROPIS CAMPESTRIS.
18496. HEDYSARUM OBSCURUM.
18497. TRIFOLIUM CAESPITOSUM.
18498. TRIFOLIUM ALPINUM.

18499. PINUS EDULIS. **Nut pine.**

From New Mexico. Received through Mr. H. B. Beck, Austin, Tex., May 1, 1906.

For exchange.

18500. CEREUS sp.

From Brownsville, Tex. Received through Mr. O. W. Barrett, May 4, 1906.

18501 to 18504. ANDROPOGON SORGHUM. **Sorghum.**

From Curaçao, Dutch West Indies. Presented by Mr. I. Wesleyn, Superintendent of Agriculture. Received May 8, 1906.

18501. *Doerah.*
18502. *Kabees largoe.*
18503. *Santa Martha.*
18504. Common type.

18505. CHAETOCHLOA ITALICA. **Korean millet.**

From Yokohama, Japan. Received through the Yokohama Nursery Company, May 7, 1906.

Paytupsal.

18506. TRIGONELLA FOENUM-GRAECUM. **Fenugreek.**

From Kohat, Northwest Frontier Province, India. Received through Mr. Frank Benton (No. 70), April 30, 1906.

18507. CUCUMIS MELO. **Muskmelon.**

From Lahore, India. Received through Mr. Frank Benton, April 30, 1906.

"(No. 76.) Seed from a freshly cut melon purchased in the market at Lahore, India, in March, 1906. Melon small, round; yellow, with green marking; netted. Had a strong but rather fragrant odor, which is difficult to indicate, but reminded one of musk." (*Benton.*)

18508. ACACIA FARNESIANA. **Popinac.**

From Kohat, Northwest Province, India. Received through Mr. Frank Benton (No. 73), April 30, 1906.

(See No. 3349, Inventory No. 7, and No. 3528, Inventory No. 8.)

18509. ALBIZZIA LEBBEK. **Siris tree.**

From Dera Ismail, Northwest Province, India. Received through Mr. Frank Benton (No. 74), April 30, 1906.

18510 and 18511. TRIFOLIUM PRATENSE. **Red clover.**

From Riga, Russia. Received through Mr. Heinrich Goegginger, May 9, 1906.

18510. *Ufa.* **18511.** *Jeletz.*

18512 to 18517. ELEUSINE CORACANA. **Ragi.**

From Bangalore, South India. Presented by F. Fletcher, esq., Deputy Director of Agriculture, Bombay Presidency. Received April 27, 1906.

A collection of ragi:

18512. *Konanakombina.* **18515.** *Gidda.*

18513. *Janumuddina.* **18516.** *Sannakari.*

18514. *Balepatte.* **18517.** *Gundutanekari.*

18518. ANDROPOGON SORGHUM. **Sorghum.**

From Manchuria. Received through the Yokohama Nursery Company, May 9, 1906.

"*Kaulien* sorghum of Manchuria, which forms the staple produce of that country and which has been made famous in the last year. It grows 8 to 10 feet high; the stalks and grain were indispensable for all concerned." (*Yokohama Nursery Company.*)

18519 to 18522. VIGNA UNGUICULATA. **Cowpea.**

From Richmond, Va. Received through T. W. Wood & Sons, May 9, 1906.

18519. *Clay.* **18521.** *Whippoorwill.*

18520. *Red Ripper.* **18522.** *New Era.*

18523 and 18524. ARACHIS HYPOGAEA. **Peanut.**

From Chepauk, Madras Presidency, South India. Presented by Mr. C. A. Barber, government botanist. Received May 9, 1906.

18523. *Country* groundnut. (C. A. B. No. 3153.)

18524. *Local Mauritius* groundnut. (C. A. B. No. 3154.)

18525 to 18529. MUSA SAPIENTUM. **Banana.**

From Manila, P. I. Presented by Mr. W. S. Lyon, horticulturist, Bureau of Agriculture. Received May 11, 1906.

18525. *Saba.*

18526. *Butuhan.*

18527. *Lacatan.*

18528. *Matabia.*

18529. *Latundan.*

18530. RAPHIDOPHORA MERRILLII.

From Manila, P. I. Presented by Mr. W. S. Lyon, horticulturist, Bureau of Agriculture. Received May 11, 1906.

18531 to 18534. ZEA MAYS. **Corn.**

From Juarez, Chihuahua, Mexico. Presented by Mr. Elmer Stearns. Received May 10, 1906.

Four varieties of dent corn.

18531. *Maiz blanco* (white corn).

18532. *Jaraleno.*

18533. *Temporal.*

18534. *El Coahuileno.*

18535. ACTINIDIA CHINENSIS. **Yang taw.**

From Kuling, Kiukiang, Kiang-si, China. Presented by Rev. Hugh W. White. Received May 15, 1905. (See S. P. I. No. 11629, Inventory No. 11.)

"The plant grows wild here, and is not known in the United States; indeed, I have seen it nowhere else in China. We find it a delicious fruit with excellent medicinal effect on the digestion. The place is about the latitude of Galveston, but it is on a mountain 3,500 feet high and has a climate not unlike Virginia or North Carolina. In winter there is an abundance of snow and ice. The subsoil is a poor, stony, red soil, but is covered with a few inches of black wood earth. There is much rainfall. The plant grows like a grape, and the fruit is single, between the size of a hickory nut and a walnut, with a russet-looking green skin and a consistency much like the green fig. If it can be cultivated it will make a valuable fruit." (*White.*)

18536 and 18537. CHENOPODIUM QUINOA. **Quinoa.**

From La Paz, Bolivia. Presented by Mr. Arthur L. Jackson, of the Andes Trading Company. Received May 19, 1906.

18536.

Canana. A dark-seeded variety of poor quality.

18537.

Common. A white-seeded variety most commonly grown.

"I find that there are three kinds of quinoa commonly grown here, though one is rather rare and hard to get. I am sending you samples of two varieties in this mail. The third variety is the *Quinoa Real* (or *Royal Quinoa*), which is a much taller plant. Quinoa here is principally used by the Indians. They make various kinds of foods and a drink out of it. The latter is called *Chicha* and when fermented is quite intoxicating. *Chicha* is also made out of other ingredients, such as peanuts. Quinoa is also much used as rice is used in soups, and the Indians make a dish out of it which looks like a sort of watery mush or hominy, which is not bad to eat. They also grind it up on a stone and make a kind of Indian bread, like coarse Gra-

18536 and 18537—Continued.

ham bread, which is good and much more nutritious, or so they claim, than corn or meal bread. I have been told that quinoa does not grow well at a less altitude than about 8,000 feet." (*Jackson.*)

18538. LILIUM LONGIFLORUM EXIMIUM. **Easter lily.**

From Washington, D. C. Numbered May 23, 1906.

Plants grown from seed propagated in the Department greenhouse.

18539. CARISSA ARDUINA. **Amatungulu.**

From Cape Town, South Africa. Presented by the Corporation of the City of Cape Town Public Gardens. Received May 21, 1906.

(See No. 9612, Inventory No. 10; and Nos. 13239 and 13967, Inventory No. 11.)

18540 to 18542. HORDEUM spp. **Barley.**

From Svalöf, Sweden. Received through Dr. N. H. Nilsson, of the Swedish Seed Breeding Institute, May 24, 1906.

Pedigreed brewing barleys produced by selection and each variety said to be 100 per cent pure seed. (See Nos. 10583, 10585, and 10586, Inventory No. 11, for description.)

18540. HORDEUM DISTICHUM NUTANS.

Hannchen.

18541. HORDEUM DISTICHUM ERECTUM.

Primus.

18542. HORDEUM DISTICHUM NUTANS.

Prinsess.

18543 to 18545. SOLANUM MELONGENA. **Eggplant.**

From Cairo, Egypt. Presented by Mr. George P. Foaden, of the Khedivial Agricultural Society. Received May 26, 1906.

18543. A BLACK-FRUITED VARIETY.

18544. A WHITE-FRUITED VARIETY.

18545. A ROUND, VIOLET-FRUITED VARIETY.

18546 to 18548.

From Toledo, Ohio. Received through S. W. Flower & Co., May 26, 1906.

18546. TRIFOLIUM PRATENSE. **Red clover.**

Mammoth.

18547. TRIFOLIUM HYBRIDUM. **Alsike.**

18548. PHLEUM PRATENSE. **Timothy.**

18549. ACACIA sp. **Acacia.**

From Jammu, Kashmir. Received through Mr. Frank Benton, May 29, 1906.

"An *Acacia* which grows wild on very poor, dry, and stony soil in southern Kashmir. It is used as a hedge plant. Single specimens standing alone sometimes attain a diameter of 2 feet at base of trunk and 30 to 40 feet in height. Covered in April with a profusion of ornamental white, tassel-like blossoms, which are quite freely visited by bees and yield a fine quality of honey." (*Benton.*)

18550. CITRUS AUSTRALASICA. **Finger lime.**

From Wellington Point, near Brisbane, Queensland, Australia. Presented by Mr. James Pink. Received May 29, 1906.

(See No. 14993, Inventory No. 11.)

18551 to 18556. TRIFOLIUM PRATENSE. **Red clover.**

From Oakland, Nebr. Grown on the ranch of Mr. John P. Young from seed planted in 1905 and resown at same place in the spring of 1906.

A collection of red clover seed used in the plant life history experiments being conducted by Mr. C. J. Brand, of this Department.

18551. Missouri seed. (No. 6.)

18552. Commercial seed. (No. 9.)

18553. Nebraska seed. (No. 11.)

18554. Courland (Russia) seed. (No. 18.)

18555. Wisconsin seed. (No. 19.)

18556. Pennsylvania seed. (No. 21.)

18557 to 18560. ELEUSINE CORACANA. **Ragi.**

From Bangalore, South India. Presented by Mr. F. Fletcher, Deputy Director of Agriculture, Bombay Presidency. Received May 31, 1906.

18557. *Dodda.*

18558. *Madayangiri.*

18559. *Majjige.*

18560. *Hasarukambi.*

18561 to 18626.

From China. Received through Mr. F. N. Meyer, at the Plant Introduction Garden, Chico, Cal., May 18, 1906.

Seeds and cuttings of Chinese plants, the seeds being indicated by the letter "a" following the numbers, as follows:

18561. MORUS ALBA. **Mulberry.**

From Tang-hsi. (No. 140.)

18562. MORUS ALBA. **Mulberry.**

From Shanghai. (No. 514.)

18563. MORUS ALBA. **Mulberry.**

From Tang-hsi. (No. 520.)

18564. PITTOSPORUM TOBIRA.

From Shanghai. (No. 200a.)

18565. ZIZYPHUS SATIVA. **Jujube.**

From Peking. (No. 201a.)

18566. EUONYMUS JAPONICUS.

From Hankow. (No. 141.)

18567. EUONYMUS sp.

From Tang-hsi. (No. 142.)

18568. ELAEAGNUS sp.

From Hankow. (No. 143.)

18569. ALTINGIA CHINENSIS.

From Hankow. (No. 145.)

18570. SMILAX sp.

From Tang-hsi. (No. 146.)

18571. (Undetermined.)

From Tang-hsi. (No. 147.)

18572. DAPHNE sp.

(No. 148.)

18573. CHIMONANTHUS FRAGRANS.

From Hankow. (No. 503.)

18574. HIBISCUS SYRIACUS. **Rose of Sharon.**

From Hankow. (No. 505.) Cuttings.

18575. HIBISCUS SYRIACUS. **Rose of Sharon.**

From Hankow. (No. 192a.) Seeds.

18561 to 18626—Continued.

18576. Rosa rugosa. **Rose.**

From Shanghai. (No. 506.)

18577. Juniperus chinensis. **Chinese juniper.**

From Shan-hai-kwan. (No. 166a.)

18578. Acer mono. **Maple.**

From Wei-tsan Mountains, near Peking. (No. 169a.) Seeds sent under No. 67a, S. P. I. No. 17898.

18579. Gleditsia sp.

From Wei-tsan Mountains, near Peking. (No. 174a.)

18580. Hibiscus manihot.

From Peking. "(No. 180a.) A perennial *Althaea* or a *Hibiscus* with very large, bright yellow flowers. Brought from southern China to Peking by Dr. N. S. Hopkins, from whose son I obtained the seeds." (*Meyer.*)

18581. Lycium sp. **Matrimony vine.**

From Palitswang. "(No. 182a.) A matrimony vine which is trained on one stem, with small branches drooping down like a weeping tree. Cuttings sent under No. 86, S. P. I. No. 18271." (*Meyer.*)

18582. Rhamnus sp.

From Tchang-ping-tcho. (No. 184a.)

18583. Viburnum odoratissimum.

From Shanghai. (No. 191a.)

18584. Actinidia chinensis. **Yangtaw.**

From Hankow. "(No. 194a.) Obtained from Mr. F. J. Brown, of Hankow, who received the seeds from Ichang. Mr. Brown says it is a vine bearing nice edible fruits, something like large gooseberries, with rough skin." (*Meyer.*)

18585. Prunus sp. **Plum.**

From Tang-hsi. (No. 144.)

18586. Prunus sp. **Plum.**

From Shanghai. (No. 509.)

18587. Prunus sp. **Cherry.**

From Tang-hsi. (No. 519.)

18588. Amygdalus persica. **Peach.**

From Shanghai. (No. 501.)

18589. Amygdalus persica. **Peach.**

From Shanghai. (No. 502.)

18590. Amygdalus persica. **Peach.**

From Shanghai. (No. 508.)

18591. Amygdalus persica. **Peach.**

From Shanghai. (No. 510.)

18592. Amygdalus persica. **Peach.**

From Shanghai. (No. 511.)

18593. Amygdalus persica. **Peach.**

From Shanghai. (No. 512.)

18594. Amygdalus persica. **Peach.**

From Shanghai. (No. 513.)

18561 to 18626—Continued.

18595. AMYGDALUS DAVIDIANA (?).

From Tientsin. (No. 168a.)

18596. DIOSPYROS KAKI. **Persimmon.**

From Shanghai. "(Nos. 504 and 516.) Said to be a seedless persimmon of medium size." (*Meyer.*)

18597. DIOSPYROS KAKI. **Persimmon.**

From Tang-hsi. "(No. 517.) Said to be a large, seedless persimmon of very sweet taste." (*Meyer.*)

18598. DIOSPYROS sp. **Persimmon.**

From Tang-hsi. "(No. 518.) A persimmon growing wild in different places and used as a stock for the larger seedless ones. Is an entirely different species from the one used in northern China; has a smooth, white bark." (*Meyer.*)

18599. DIOSPYROS sp. **Persimmon.**

From Chang-li. "(No. 161a.) Seed of the wild persimmon used as stock for the large seedless varieties, and the fruits, too, are used in a semidried state, being a poor people's fruit." (*Meyer.*)

18600. MALUS MALUS. **Apple.**

From Shanghai. (No. 507.)

18601. CYDONIA JAPONICA. **Japanese quince.**

From Peking. (No. 173a.)

18602. VITIS sp. **Grape.**

From Hankow. "(No. 515.) A purple grape, bearing medium-sized bunches; said to have been introduced by the station missionaries. If so, it might be a fine grape for the South Atlantic States, as the climate in Hankow is very similar to that of the Southern States. (*Meyer.*)

18603. JUGLANS REGIA. **Persian walnut.**

From Chang-li. "(No. 162a.) A very large, paper-shell walnut, the largest one to be had. Owner was not willing to show the tree, so could not obtain scions. (*Meyer.*)

18604. JUGLANS REGIA. **Persian walnut.**

From Chang-li. "(No. 163a.) A sample of large, well-formed nuts, of which scions were sent under No. 48, S. P. I. No. 17747." (*Meyer.*)

18605. PISTACIA CHINENSIS. **Pistache.**

From Wei-tsan Mountains near Peking. (No. 170a.) The same as No. 63a, S. P. I. No. 19391.

18606. BRASSICA PE-TSAI. **Pe-tsai cabbage.**

From Hankow. (No. 193a.)

18607. SESAMUM INDICUM. **Sesame.**

From Shanghai. (No. 189a.) *Black.*

18608. MEDICAGO sp.

From Peking. (No. 183a.)

18609. (Undetermined.)

From Shan-hai-kwan. (No. 181a.)

18610. ANDROPOGON SORGHUM. **Sorghum.**

From Shan-hai-kwan. "(No. 153a) A white-grained variety of sorghum grown on rather alkaline land." (*Meyer.*)

18561 to 18626—Continued.

18611. ANDROPOGON SORGHUM. **Sorghum.**

From Shan-hai-kwan. "(No. 154a.) A light brown colored variety of sorghum grown on rather alkaline land." (*Meyer.*)

18612. ANDROPOGON SORGHUM. **Sorghum.**

From Shan-hai-kwan. "(No. 155a.) A dark brown colored variety of sorghum grown on rather alkaline land." (*Meyer.*)

18613. ANDROPOGON SORGHUM. **Sorghum.**

From Peking. "(No. 172a.) White seeded. Given to me by Mr. J. T. Headlands, of the Methodist Mission, Peking. This is the drooping variety used to make brooms from." (*Meyer.*)

18614. ANDROPOGON SORGHUM. **Sorghum.**

From Peking. (No. 172a.) Brown seeded. (For description see No. 18613.)

18615. ORYZA SATIVA. **Rice.**

From Shan-hai-kwan. "(No. 156a.) An upland rice grown sparsely around here; seems to succeed on rather alkaline land. Should be hardy as far as New York or in Illinois. Probably the same as No. 40a (S. P. I. No. 17915), but is from a different locality." (*Meyer.*)

18616. ORYZA SATIVA. **Rice.**

From Chang-li. "(No. 157a.) An upland rice growing on rather moist land." (*Meyer.*)

18617. VIGNA UNGUICULATA. **Cowpea.**

From Shan-hai-kwan. "(No. 158a.) A brown and white spotted bean." (*Meyer.*)

18618. PHASEOLUS ANGULARIS. **Adzuki bean.**

From Shanghai. (No. 187a.)

18619. GLYCINE HISPIDA. **Soy bean.**

From Shanghai. "(No. 188a.) A very large variety of yellow soy bean." (*Meyer.*)

18620. PANICUM MILIACEUM. **Broom-corn millet.**

From Shan-hai-kwan. (No. 159a.)

18621. CHAETOCHLOA ITALICA. **Millet.**

From Shan-hai-kwan. (No. 160a.)

18622. CHAETOCHLOA ITALICA. **Millet.**

From Shan-hai-kwan. (No. 165a.)

18623. GOSSYPIUM sp. **Cotton.**

From Chang-li. (No. 164a.)

18624. SAPIUM SEBIFERUM. **Tallow tree.**

From Shanghai. (No. 190a.)

18625. ANDROPOGON SORGHUM. **Sorghum.**

From Kung-ki-tschang. (No. 171a.) Red seeded.

18626. ANDROPOGON SORGHUM. **Sorghum**

From Kung-ki-tschang. (No. 171a.) White seeded.

18627 and 18628. MEDICAGO SATIVA. **Alfalfa.**

From Bassorah, Arabia. Received from Mr. Herbert W. Poulter, through Mr. David Fairchild, June 12, 1906.

Arabian alfalfa or *Jet*.

18627. Seed from irrigated plants.

18628. Seed from unirrigated plants.

18629. MEDICAGO SATIVA. **Alfalfa.**

From Buffalo, N. Y. Received through the Harvey Seed Company, June 13, 1906.

Canadian grown alfalfa.

18630. PHOENIX DACTYLIFERA. **Date.**

From Morocco. Received through McCaig, Gilchrist & Co., Glasgow, Scotland, May 28, 1906.

Tafilalt. "Groves of this date occur in the oases of the region of Tafilalt, and this is supposed to be the largest variety grown there. It is in any case that variety which is most largely exported from Morocco, especially to the English market." (*Fairchild.*)

18631. IPOMOEA BATATAS. **Sweet potato.**

From Paoli, Ind. Presented by Braxtan Brothers. Received June 1, 1906.

This variety is of a peculiar and unusual shape, resembling a muskmelon. "Raised from a sweet potato plant and bought by us in a lot of sweet potatoes last December and kept since lying around the store with no care whatever as to its preservation, while our sweet potatoes rotted right along." (*Braxtan.*)

18632. CANNABIS SATIVA. **Hemp.**

From Shinmintong District, Manchuria. Received through the Yokohama Nursery Company, Yokohama, Japan, May 29, 1906.

"Manchurian hemp seeds produced in the district of Shinmintong, some 200 miles southwest of Kirin Province." (*Yokohama Nursery Company.*)

18633. ANDROPOGON SORGHUM. **Sorghum.**

From Turks Island, West Indies. Presented by Mr. J. A. Howells, United States consul. Received June 4, 1906.

"*Guinea corn*, the principal crop on this island for grain and fodder." (*Howells.*)

18634. XANTHOSOMA sp. **Yautia.**

From Chiapas, southern Mexico. Presented by Mr. Lawrence Harmon, of Chicago, Ill. Received April 26, 1906. Additional roots were received June 14, 1906.

Roots of a semiwild yautia found growing wild in Chiapas; said to be eaten by the natives, but not cultivated by them.

"These were shipped from the city of San Juan Bautista, Tabasco, Mexico, and it is supposed that they were brought into that city by the peons, who gathered them in that immediate vicinity. It is further understood that there is no systematic attempt made to cultivate them, and that they practically grow wild under varying circumstances, which might in some measure account for variations found in them." (*Harmon.*)

18635. PISTACIA CABULICA (?).

From Chaman, British India. Presented by Lieut. W. L. Maxwell, One Hundred and Twenty-Seventh Baluchistan Light Infantry. Received June 4, 1906.

"These wild nuts are much eaten by the Pathans around here. With regard to planting them, the following information may be useful: The Pathans say that a new tree only grows where one of the hill partridges eats a nut and passes it through in its excreta on to suitable ground. I asked the forest officer in Quetta if there could be any truth in this extraordinary statement. He told me that he had several trees growing in the Quetta plantations, and that all had been grown from seed so treated. The reason presumably is that the oil, in which these nuts are very rich, must first be extracted from the seeds. I heard from a cultivator here that if the seeds were well rubbed between the hands until all the oil was extracted, satisfactory results were obtained from planting them. The seeds ripen in August." (*Maxwell.*)

18636. PISTACIA VERA. **Pistache.**

From Viernyi, Semiryetchensk Province, Turkestan. Presented by Mr. E. Valneff, through Mr. E. A. Bessey, of the Subtropical Labratory, Miami, Fla. Received June 4, 1906.

"Pistache seeds from north Persia, the best that we know." (*Valneff.*)

18637. PISTACIA INTEGERRIMA. **Zebra wood.**

From Khost, India. Presented by Mr. Philip Parker, of the Indian Irrigation Service, through Mr. J. S. Davis, executive engineer, Bannu, Kuram Valley Irrigation Project. Received June 4, 1906.

"This is the famous zebra wood of Kakra, India, which grows to be a large tree 40 feet or more high, with a trunk in diameter from 2½ to 3 feet, or even as much as 4¾ feet. It grows on the warm slopes of the Himalaya Mountains in northern India, usually at an altitude of from 1,200 to 8,000 feet. The wood is very hard and close grained, brown in color, and beautifully mottled with yellow and dark veins, whence the name 'zebra wood.'

"Stewart and Brandis, in their 'Forest Flora of Northwest and Central India,' say: 'The heartwood of mature trees is the best and most handsome wood of the northwest Himalaya for carving, furniture, and all kinds of ornamental work.'

"According to Mr. Bolton, settlement officer at Dehra Ishmail Kahn, this species is difficult to cultivate, 'as it is necessary for the seed to pass through the intestines of a bird before it can germinate.'

"Mr. Parker writes as follows: 'I gave one seed to a bird (fowl) that was to be killed the next day and told my cook to give me the seed when drawing the bird. I have just noticed that the seed, after being put in water, has begun to germinate, so evidently the Indian fowl is good enough.'

"This species is very little known, but it is of some promise as an ornamental and even perhaps as a timber tree in some parts of the southwest." (*Swingle.*)

18638. AGAVE RIGIDA SISALANA. **Sisal.**

From Paramaribo, Surinam. Presented by Dr. C. J. J. Van Hall, Director of Agriculture for the Dutch West Indies. Received at the Porto Rico Agricultural Experiment Station, Mayagnez, P. R., in May, 1906.

"Parent plants are believed to be direct descendants of plants in the Trinidad Botanical Gardens which were brought from Yucatan, Mexico." (*Barrett.*)

18639 and 18640. ONOBRYCHIS ONOBRYCHIS. **Sainfoin.**

From Paris, France. Received through Vilmorin-Andrieux & Co., June 4, 1904.

18639. Double. **18640.** Common.

18641 to 18651. CYAMOPSIS TETRAGONOLOBA. **Guar.**

From Surat, India. Presented by Mr. F. Fletcher, Deputy Director of Agriculture, Bombay Presidency. Received June 4, 1906.

Nadiad varieties:

18641.

Sotia. The seed of this variety is principally used as cattle food. It is also sown in beds of ginger, turmeric, etc., to serve as shade plants to young shoots.

18642.

Wakardia. The pods of this variety are used as a green vegetable.

18643.

Telia. This is also sown for vegetable purposes, but it is considered superior to *Wakardia* on account of its being more smooth.

18644.

Pardeshi. Used as a vegetable.

Surat varieties:

18645.

Talabda. Seed used as cattle food.

18646.

Sotia. Chiefly used as a vegetable; but in the case of valuable garden crops, such as ginger, turmeric, suran, etc., it serves a double purpose, viz, as a shade plant and as green manure.

18647.

Makhania. Used only as a vegetable.

Dhulia varieties:

18648.

Botkya. A short-podded variety used as a vegetable.

18649.

Telia. A long-podded variety used as a vegetable; cooks better than the *Botkya.*

Dharwar varieties:

18650.

Turai charali. Used as a vegetable.

18651.

Chole charali. Used as a vegetable.

18652 to 18661. DIOSCOREA spp. **Yam.**

From Mayaguez, P. R. Received at the Subtropical Laboratory and Garden, Miami, Fla., in May, 1906.

A collection of yams, as follows:

18652. DIOSCOREA TRIFIDA.

Negro or *Yampee* (ex Jamaica).

18653. DIOSCOREA TRIFIDA.

Mapuey Blanco. White roots.

18654. DIOSCOREA TRIFIDA.

Mapuey Colorado. Purple roots.

18655. DIOSCOREA PENTAPHYLLA (?).

(Ex Hawaii.)

18652 to 18661—Continued.

18656. Dioscorea bulbifera.

Guada. Large irregular-shaped axillary bulbils.

18657. Dioscorea alata (?).

Barbados Table (ex Jamaica).

18658. Dioscorea alata (?).

White Lisbon (ex Jamaica).

18659. Dioscorea aculeata.

Lucia (ex Jamaica).

18660. Dioscorea aculeata.

Guinea. Best yam in Porto Rico from cultural standpoint.

18661. Dioscorea aculeata (?).

Congo. Yellow root.

18662. Asparagus sp.

From Peking, China. Received through Mr. F. N. Meyer, June 4, 1906.

"Berry taken from a plant growing in the Temple of Heaven grounds in Peking, September 2, 1905." (*Meyer.*)

18663 and 18664.

From Darmstadt, Germany. Received through Mr. Conrad Appel, June 4, 1906.

18663. Poa trivialis. **Rough-stalked meadow grass.**

18664. Medicago sativa. **Alfalfa.**

Provence.

18665. Pinus insularis. **Benguet pine.**

From Manila, P. I. Presented by Capt. George P. Ahern, Director of Forestry. Received June 4, 1906.

Seed obtained from Benguet Province.

18666. Hordeum distichum nutans. **Barley.**

From Brünn, Austria. Presented by Prof. J. Vanha. Received in March, 1906.

Hanna.

18667 to 18673.

From Cape Town, South Africa. Presented by the director of the Cape Town Public Gardens. Received June 2, 1906.

18667. Aberia caffra. **Kei-apple.**

18668. Asparagus crispus.

18669. Asparagus sarmentosus.

18670. Asparagus sprengeri.

18671. Carissa arduina. **Amatungulu.**

18672. Diosma crenata. **Buchu.**

18673. Opuntia sp. **Prickly pear.**

18674. Vicia sativa. **Common vetch.**

From Portland, Oreg. Received through the Portland Seed Company, June 7, 1906.

18675 and 18676. ARACHIS HYPOGAEA. **Peanut.**

From Muanza, German East Africa. Presented by Prof. Dr. A. Zimmermann, Amani. Received June 8, 1906.

18675. A variety with red skin.

18676. A variety with brown skin.

18677. MEDICAGO SATIVA. **Alfalfa.**

From Traverse City, Mich. Received through Mr. J. M. Westgate, June 11, 1906.

Seed gathered from two-year-old plant on the farm of Mr. C. R. Dockeray, Traverse City, Mich., June 1, 1905.

18678. MEDICAGO SATIVA. **Alfalfa.**

From Split Rock, N. Y. Received through Prof. A. S. Hitchcock, June 11, 1906.

Seed gathered October 6, 1904.

18679 and 18680. ZEA MAYS. **Corn.**

From Magyar Óvár, Hungary. Presented by Prof. Kern Hermann, through Mr. Edgar Brown. Received June 2, 1906.

Two varieties of flint corn, as follows:

18679. *Cinquatino.* **18680.** *Sehr früher von Alcinth.*

"These two corns are varieties of the small early flint type which is now being cultivated to a considerable extent in Hungary. They are very small in size, the ears about 6 inches long, with the kernels about the size of our larger popcorns. The grains are nearly free from starch, with a rather large embryo. On account of the small size of the stalks, this corn is planted close together, the rows being about 20 inches apart and the hills from 8 to 10 inches apart in the row. The average yield is from 20 to 25 bushels per acre." (*Brown.*)

18681 to 18683.

From Teheran, Persia. Presented by Mr. John Tyler, United States vice-consul-general. Received June 1 and 11, 1906.

18681. PAPAVER SOMNIFERUM. **Opium poppy.**

18682. NICOTIANA TABACUM. **Tobacco.**

18683. PISTACIA VERA. **Pistache.**

"Persian 'Pista' grown in the district of Damghân, about 200 miles east of Teheran. Nuts from this place have the reputation of being the best, purest, and most qualified to resist attacks of parasites." (*Tyler.*)

18684. ANDROPOGON SORGHUM. **Milo.**

From Memphis, Tex. Received through Mr. J. F. Bradley, June 13, 1906.

Extra Dwarf.

18685 to 18688.

From Honolulu, Hawaii. Presented by Hon. David Haughs, acting director of Forestry. Received June 11, 1906.

18685. BAUHINIA TOMENTOSA. **St. Thomas tree.**

18686. CASUARINA GLAUCA. **Blue ironwood.**

18687. CASUARINA STRICTA. **Australian ironwood.**

18688. SYNCARPIA LAURIFOLIA. **Turpentine tree.**

18689 to 18691. CHENOPODIUM QUINOA. **Quinoa.**

From La Paz, Bolivia. Received through Señor M. V. Ballovian, Ministerio de Colonias y Agricultura, June 14, 1906.

18689. *Common.*

18690. *Royal.*

18691. *Kanagua.*

(See Nos. 18536 and 18537.)

18692. TRIFOLIUM REPENS. **White clover.**

From Lodi, Italy. Received through Prof. Carlo Besana, June 16, 1906. Introduced by Mr. Edgar Brown, of the Bureau of Plant Industry.

Lodino.

18693 to 18698. PHOENIX DACTYLIFERA. **Date.**

From M'Zab, in the Algerian Sahara. Received through Mr. Yahia ben Kassem, June 16, 1906.

According to Mr. Yahia ben Kassem this lot includes the varieties *Tazzizaoute* and *Beni Kbala*. Upon examination of the offshoots, however, Mr. Swingle found a label, written in Arabic, upon each of the plants, which he succeeded in deciphering as *Timjoohert*, which is described in his letter as follows:

Timjoohert. A soft date from the M'Zab region of the Algerian Sahara; fruit of a rich, red-brown color when ripe, 1½ to 1¾ inches long, three-fourths to seven-eighths inch wide; flesh without fiber, very sweet, and of exceedingly good flavor, considered by some to be superior to the *Deglet noor*. It is a sticky date and its sirupy juice exudes from the ripening fruit in such abundance as to drip from the tree. It will require a process of curing to get rid of this sirup, but this variety is of such good quality that it may, nevertheless, prove profitable in commercial culture, especially in regions where the *Deglet noor* can not mature. It may furnish a good second-class date which can be sold in competition with the selected Oriental dates which now reach our markets from Busra and Muscat.

18699 and 18700.

From Darmstadt, Germany. Received through A. Le Coq & Co., June 16, 1906.

18699. MELILOTUS ALBA. **Sweet clover.**

Bokhara.

18700. VICIA VILLOSA. **Hairy vetch.**

18701 to 18703.

From Reading, England. Received through Sutton & Sons, June 15, 1906.

18701. CRAMBE MARITIMA. **Sea kale.**

18702. CYNARA SCOLYMUS. **Artichoke.**

Purple Globe.

18703. CYNARA SCOLYMUS. **Artichoke.**

Selected Large Green.

18704. CHRYSOPHYLLUM sp.

From Piracicaba, Brazil. Presented by Dr. J. W. Hart, director of the Agricultural College. Received June 7, 1906.

18705. PANICUM LAEVIFOLIUM.

From Pretoria, Transvaal. Presented by Prof. J. Burtt Davy, of the Transvaal Department of Agriculture. Received June 18, 1906.

18706. AMYGDALUS DAVIDIANA.

From Peking, China. Received through Mr. F. N. Meyer (No. 167a), May 18, 1906.

Seeds of the wild peach, scions of which were sent under Nos. 126, 127, and 129 (S. P. I. Nos. 17729 to 17731); from the mountains near Fangshan.

18707. GLYCINE HISPIDA. **Soy bean.**

From China. Renumbered for convenience in recording distribution, June 21, 1906.

A dull reddish brown colored variety of soy beans, the actual source of which is in doubt.

18708 to 18725.

From San Jose, Costa Rica. Presented by Mr. E. C. Rost, through Mr. L. C. Corbett, horticulturist of the Bureau of Plant Industry. Received June 20, 1906.

A collection mostly of economic plants, with notes by Mr. E. C. Rost.

18708. (Undetermined.)

An evergreen vine with white, star-shaped flowers.

18709. (Undetermined.) **Palm.**

18710. CARICA PAPAYA. **Papaw.**

18711. IPOMOEA sp. **Morning-glory.**

Seed of a wild variety.

18712. IPOMOEA sp. **Morning-glory.**

Blue Giant.

18713. CANNA sp.

18714. (Undetermined.) **Gavilana.**

A tree with leaves like the American mountain ash; has yellow flowers somewhat resembling the locust. Should do well in the extreme south.

18715. ANONA sp.

18716. COBAEA SCANDENS.

18717. MUCUNA sp.

18718. (Undetermined.)

18719. ARGEMONE MEXICANA. **Mexican poppy.**

18720. (Undetermined)

Seed, in a flat, round, spiny pod resembling a sea urchin. Grows on a tall tree with yellow flowers.

18721. GOSSYPIUM sp. **Cotton.**

A few seeds of everbearing, large, native tree cotton.

18722. SOLANUM TUBEROSUM. **Potato.**

Pacaya.

18723. SOLANUM TUBEROSUM. **Potato.**

A potato introduced from Peru.

18724. SOLANUM TUBEROSUM. **Potato.**

A yellow-colored potato introduced from Peru.

18725. SOLANUM TUBEROSUM. **Potato.**

A dark wine-colored potato introduced from Peru.

18726. DOLICHOS LUBIA.

From Paris, France. Received through Messrs. Vilmorin-Andrieux & Co., June 22, 1906.

18727 to 18749.

From Bahama Islands, British West Indies. Collected by Mr. P. J. Wester in April, 1906.

A collection of plants, seeds, and cuttings thought to be of value in the subtropical region of Florida, either as economics or ornamentals, the proximity to the Bahamas and nearly similar climatic conditions making it very probable that these introductions will thrive well in the vicinity of Miami, where they have been planted in the Subtropical Laboratory and Garden.

The accompanying notes are by Mr. Wester.

18727. CITRUS DECUMANA. **Pomelo.**

"Mr. Flagler is reported to have said that he ate better pomelos in the Bahamas, from seedling trees, than any that he tasted in Florida. Upon inquiry it was found that some of this fruit had been supplied by R. S. Johnstone, circuit judge, Nassau, New Providence, Bahamas, who, on solicitation, presented me with budwood from two seedling trees, the fruit of which he considered very superior. The fruit is said to be rather small, but very juicy and sweet." (Lab. No. 460.)

18728. CITRUS DECUMANA. **Pomelo.**

"Fruit said to be of superior value. Budwood presented by Judge R. S. Johnstone." (Lab. No. 461.)

18729. PERSEA GRATISSIMA. **Avocado.**

Johnstone. "Budwood secured through Judge R. S. Johnstone, who gave the following description of the fruit: 'Pear-shaped, but rather broad at basal end; skin smooth, thin; flesh yellow, almond-flavored; seed large; famous as the best avocado in the Bahamas. Ripens in August and September.'" (Lab. No. 462.)

18730. PERSEA GRATISSIMA. **Avocado.**

Largo. "Budwood presented by Mr. C. H. Matthews, from a large tree. He described the fruit as follows: 'Egg-shaped; very large, 3¼ to 4 pounds in weight; skin green, very thin; flavor very good; seed small; ripens in August and September.'" (Lab. No. 464.)

18731. PERSEA GRATISSIMA. **Avocado.**

Grant. "Buds secured from a tree in Grantown, said by its colored owner to bear extra early fruit of good quality. The young fruits were well advanced in size for the season when the budwood was obtained, which seemed to substantiate the owner's assertion." (Lab. No. 465.)

18732. HIBISCUS ROSA-SINENSIS. **Chinese hibiscus.**

"Budwood secured from plants in the garden of Hotel Colonial, Nassau, New Providence. Flowers distinct from any of the forms seen in Florida; semidouble, very dark red with a purple tinge, making it a distinct acquisition." (Lab. No. 467.)

18733. VANILLA sp.

"Plants collected on Soldiers road, New Providence. This vanilla grows on land of a very rocky character with a scanty layer of soil. The vegetation does not exceed 12 feet, and the average height of a shrub is 8 feet. It was interesting to note that the foliage was very sparse, affording very little shade. The growth of the vanilla was exceedingly stocky and strong. In appearance the plant resembles the *V. eggersii* in Florida, except that the bract-like leaves of the latter are entirely absent in the Bahama species. The nodes on the latter species are also closer than those on the species from Florida." (Lab. No. 470.)

18727 to 18749—Continued.

18734. Ficus benjamina.

"Used as a shade tree on the streets of Nassau, New Providence. Unquestionably one of the most noble and majestic of shade trees, with dark evergreen foliage. Appears to stand the dust and heat of the street better than any tree I have seen. Cuttings presented by M. Clavel, head gardener, Hotel Colonial, Nassau, New Providence." (Lab. No. 473.)

18735. (Undetermined.)

"Native name 'Spanish Thyme.' A plant belonging to the family Scrophulariaceae, with fleshy, succulent leaves used in the Bahamas for flavoring soups. Cuttings secured in Grantown, New Providence." (Lab. No. 474.)

18736. Anona reticulata. **Custard apple.**

"Budwood secured from a tree in Grantown, having very large fruit, 14½ inches in circumference. Fruit heart-shaped, yellow, netted with crimson veins, crimson on one side, making it exceedingly handsome; tree said by owner to be very prolific. Fruit of good quality." (Lab. No. 478.)

18737. Anona muricata. **Soursop.**

"Budwood secured from a prodigiously prolific tree. As fruits were not mature, there was no opportunity to judge of the quality." (Lab. No. 484.)

18738. Tamarindus indica. **Tamarind.**

"Budwood obtained from Judge R. S. Johnstone, Nassau, New Providence. Pods with the acid so reduced as to make them relished when eaten direct from the tree, which is unusual with this fruit." (Lab. No. 487.)

18739. Althaea rosea. **Hollyhock.**

"A striking and conspicuous ornamental in Nassau, where it has become naturalized." (Lab. No. 489.)

18740. Basella alba. **Malabar nightshade.**

"Native name 'Spinach.' A plant of running and climbing habit of exceedingly vigorous growth. The leaves have a very close resemblance to spinach in form, whose tenderness and succulency they possess, and are used as spinach in the Bahamas. As the plants thrive well even during the summer months, it is thought that they will prove a valuable acquisition to the vegetable garden in south Florida during the summer months. Seed secured in Grantown, New Providence." (Lab. No. 490.)

18741. Catesbaea spinosa.

"Seed obtained from M. Clavel, head gardener, Hotel Colonial. Leaves evergreen, thick and leathery; branches armed with stout spines, making it a valuable hedge plant; flowers attractive, bell shaped, cream colored." (Lab. No. 492.)

18742. Zea mays. **Corn.**

"*Native yellow* corn presented by Mr. W. M. Cunningham, curator, Botanic Station, Nassau, New Providence. This is a variety of corn collected by Mr. Cunningham, together with Nos. 18743 to 18745, on the various islands where these varieties do quite well. South Florida has at present no variety suited to its conditions, and as the climate here and in the Bahamas is very similar, it is not improbable that some of these varieties may prove valuable introductions." (Lab. No. 495.)

18743. Zea mays. **Corn.**

Governor. "Presented by Mr. W. M. Cunningham. Native to the Bahama Islands." (Lab. No. 496.)

18744. Zea mays. **Corn.**

Native white. "Native to the Bahamas. Presented by Mr. W. M. Cunningham." (Lab. No. 497.)

18727 to 18749—Continued.

18745. ZEA MAYS. **Corn.**

Caicos yellow., "Native to the Bahamas. Presented by Mr. W. M. Cunningham." (Lab. No. 425.)

18746. DOLICHOS LABLAB. **Hyacinth bean.**

"Native name *Bonaris.* A very vigorous climbing and trailing plant, foliage resembling the cowpea, but far more vigorous. Stems slightly tinged with purple; seeds dark brown with velvety luster. Seed secured from plants growing in Grantown, New Providence." (Lab. No. 488.)

18747. DOLICHOS LABLAB. **Hyacinth bean.**

"Native name *Bonaris.* A leguminous plant with habits similar to No. 18746. The purple tinge of the stem is absent; flowers are creamy white; seed white, and much relished by the natives in cooking. Seed secured from plants growing in Grantown, New Providence." (Lab. No. 499.)

18748. PHARBITIS sp. **Morning-glory.**

"Seed collected from native plants in Nassau, New Providence. Plants climbing, but seldom 4 feet in height; foliage tomentose; flowers pale blue, about 2 inches in diameter, exceedingly ornamental and strikingly different from species of Ipomoea."

18749. RESEDA sp. **Mignonette.**

"Seed obtained from Mr. C. H. Matthews, Nassau, New Providence. A very handsome ornamental; leaves pinnatifid, of a silvery white tinge; stems 2 feet, bare, with a long spike of white flowers. A perennial."

18750. SINAPIS ALBA. **White mustard.**

From Moscow, Russia. Received through Immer & Son, June 25, 1906.

Sarepta.

18751. MEDICAGO SATIVA. **Alfalfa.**

From New York, N. Y. Received through H. Nungesser & Co., June 25, 1906.

Turkestan.

18752 to 18763.

From Singapore, Straits Settlements. Presented by Prof. H. N. Ridley, director of the Botanic Gardens. Received June 29, 1906.

18752. AMORPHOPHALLUS PRAINII.
18753. AMORPHOPHALLUS REX.
18754. AMORPHOPHALLUS SATIVUS.
18755. ALOCASIA LOWII.
18756. ALOCASIA GRANDIS.
18757. ALOCASIA LONGILOBA.
18758. ALOCASIA INDICA.
18759. ALOCASIA SINGAPORENSIS.
18760. ALOCASIA MACRORHIZA.
18761. XANTHOSOMA VIOLACEUM.
18762. XANTHOSOMA ROBUSTUM.
18763. TYPHONIUM TRIBOLATUM.

18764. ASPARAGUS MYRIOCLADUS.

From Berea, Durban, Natal. Presented by J. Medley Wood, director of the Natal Botanic Gardens. Received June 30, 1906.

18765. GARCINIA XANTHOCHYMUS.

From Honolulu, Hawaii. Presented by Mr. E. W. Jordan, through Mr. Gerrit P. Wilder. Received July 2, 1906.

18766 to 18770.

From Piracicaba, Brazil. Presented by Dr. J. W. Hart, director of the Agricultural College. Received June 7, 1906.

18766. ANONA sp.

Aritieu or *Cabeca de negro* (negro head). "Segmented fruit, heart-shaped, about 20 centimeters in diameter, sweet, aromatic, edible. Tree 15 meters, spreading, grows on poor, sandy land on the open prairie." (*Hart.*) (No. 16.)

18767. ANONA sp.

Fruita de Conde. "Similar to preceding, but the fruit is much superior. This variety has been domesticated." (*Hart.*) (No. 17.)

18768. ARAUCARIA BRASILIANA.

(No. 22.)

18769. PSIDIUM GUAJAVA. **Guava.**

Red. (No. 12.)

18770. PSIDIUM GUAJAVA. **Guava.**

White. (No. 13.)

18771 and 18772.

From Salisbury, Rhodesia, South Africa. Received from Hon. E. Ross Townsend, Secretary for Agriculture, through Mr. W. A. Driver, Dinuba, Cal., June 30, 1906. (See Nos. 12810 and 12959, Inventory No. 11.)

18771. (Undetermined.) **Marula.**

18772. (Undetermined.) **Matundulaku.**

18773. CARICA PAPAYA. **Papaw.**

From Manila, P. I. Presented by Mr. W. S. Lyon, norticulturist, Bureau of Agriculture. Received June 29, 1906.

18774 to 18785.

From Mexico. Received through Mr. G. Onderdonk, July 5, 1906.

18774 to 18782. PRUNUS ARMENIACA. **Apricot.**

18774. *Onderdonk's No. 18.*

"From place of C. Ramirez, Lagos, Jalisco. Fruit yellow, light blush, sweet, freestone, circumference 4 inches."

18775. *Onderdonk's No. 19.*

"From place of Francisco Gomez Garcia, Lagos, Jalisco. Fruit white, 4½ inches in circumference."

18776. *Onderdonk's No. 20.*

"From place of Enrique Maupin, Aquascalientes. Fruit yellow, light blush, sweet, 5 inches in circumference."

18777. *Onderdonk's No. 21.*

18778. *Onderdonk's No. 22.*

18779. *Onderdonk's No. 23.*

18780. *Onderdonk's No. 24.*

"Nos. 18777 to 18780 are from Señor Maupin's orchard at Aquascalientes. They are all of the same general character, yellow with faint blush, fruit from 4 to 5 inches in circumference."

18781. *Onderdonk's No. 15.*

Nellie. (See No. 9844, Inventory No. 10.)

18782. *Onderdonk's No. 16.*

Dorah. (See No. 9845, Inventory No. 10.)

18774 to 18785—Continued.

18783. AMYGDALUS PERSICA. **Peach.**

Procured by Mr. Oderdonk's son from El Cobre Mountain, near Guadalajara. "A very large, yellow, clingstone peach."

18784 and 18785. MALUS MALUS. **Apple.**

18784.

Perou. From place of Mr. J. R. Silliman, Saltillo. (See No. 9014, Inventory No. 10.)

18785.

Procured by Mr. Onderdonk's son from El Cobre Mountain. "Very large, rich flavor, greenish color, yellowing slightly as it ripens. No better apple in Mexico."

18786 to 18800.

From La Paz, Bolivia. Presented by Señor M. V. Ballovian, Ministerio de Colonias y Agricultura. Received July 6, 1906.

18786 to 18798. SOLANUM TUBEROSUM. **Potato.**

18786. *Phina.*
18787. *Lugui.*
18788. *Pitiguilla.*
18789. *Chiarimilla.*
18790. *Khati.*
18791. *Monda.*
18792. *Socco.*
18793. *Ajahuira.*
18794. *Queni.*
18795. *Phureja.*
18796. *Koilla.*
18797. (Label missing.)
18798. *Ajahuira.*

The label for No. 18798, *Ajahuira*, is the same as that for No. 18793, and it is not known to which lot it properly belongs, as the consignment was mixed in transit. The tubers are not alike.

18799 and 18800. OXALIS TUBEROSA. **Oca.**

18799. *Rosada.*
18800. *Morada.*

18801. (Undetermined.)

From Piracicaba, Brazil. Presented by Dr. J. W. Hart, director of the Agricultural College. Received July 7, 1906.

Native name *Caja mauga.* (Hart's No. 35.)

18802 to 18823.

From Erfurt, Germany. Received through Messrs. Haage and Schmidt, July 9, 1906.

18802. MEDICAGO MEDIA. **Sand lucern.**
18803. VICIA CALCARATA.
18804. VICIA CORDATA.
18805. VICIA CORNIGERA.
18806. VICIA CUSPIDATA.
18807. VICIA DISPERMA.
18808. VICIA FERRUGINEA.
18809. VICIA GERARDI.
18810. VICIA GLOBOSA.
18811. VICIA GRANDIFLORA.
18812. VICIA HYBRIDA.
18813. VICIA MACROCARPA.
18814. VICIA MICHAUXII.
18815. VICIA NARBONENSIS.
18816. VICIA ONOBRYCHIOIDES.
18817. VICIA PANNONICA.
18818. VICIA PEREGRINA.
18819. VICIA PICTA.
18820. VICIA PSEUDO-CRACCA.
18821. VICIA SPURIA.
18822. VICIA STRIATA.
18823. VICIA TRICOLOR.

18824 to 18826. Oryza sativa. **Rice.**

From Persia. Presented by Mr. John Tyler, United States vice-consul-general, Teheran, Persia. Received July 6, 1906.

Three samples of unhulled rice from the region south of the Caspian Sea. These samples of rice were given to Mr. Tyler by a friend whose official title is "The Sepahdor" (Commander), who owns large areas where rice of the best sorts are grown. The samples received are of three kinds and from three separate districts, but no labels accompanied them to indicate which was which.

18824. Long slender grain, light hull.

18825. Long slender grain, light hull.

18826. Short flat grain, darker hull.

18827. Medicago sativa. **Alfalfa.**

From Chicago, Ill. Received through the A. Dickinson Company, July 9, 1906.

18828. Carica papaya. **Papaw.**

From Columbia, Isle of Pines, West Indies. Presented by Dr. F. R. Ramsdell. Received July 10, 1906.

18829 and 18830. Andropogon sorghum.

From Channing, Tex. Received through Mr. J. J. Edgerton, July 13, 1906.

18829. **Kafir corn.**

Black-Hulled White.

18830. **Milo.**

Dwarf.

18831 to 18834. Cynara scolymus. **Artichoke.**

From Milan, Italy. Received through Fratelli Ingegnoli, July 16, 1906.

18831. *Grosso d' Italian.*

18832. *Violetto di Prorenza.*

18833. *Senza Spine di Venezia.*

18834. *Palla di Roma.*

18835 to 18912. Ficus carica. **Fig.**

From Niles, Cal. Received through the California Nursery Company at the Plant Introduction Garden, Chico, Cal., in March, 1906.

Nos. 18835 to 18898, inclusive, are from the Chiswick collection. A description of these varieties will be found in Bulletin No. 9, Division of Pomology, 1901.

18835. *De l'Archipel.*

18836. *Bontard.*

18837. *Grosse Marseilles.*

18838. *Peau dure.*

18839. *Negronne.*

18840. *Bourjassote noire.*

18841. *Poulette.*

18842. *Œil de Perdrix.*

18843. *Du Roi.*

18844. *Grosse Violette de Bordeaux.*

18845. *Datte.*

18846. *Monstrueuse.*

18847. *Bourjassote Grise.*

18848. *A' Bois Jaspee.*

18849. *Royal Vineyard.*

18850. *De Grasse.*

18851. *Euscaire Preto.*

18852. *Trois Recoltes.*

18853. *Monaco Bianco.*

18854. *Bondance Precoce.*

18855. *Trifer.*

18856. *Green Ischia.*

18857. *Hirta du Japon.*

18858. *St. Johns.*

18835 to 18912—Continued.

18859. *Vebra.*
18860. *Datte Quotidienne.*
18861. *Arbal.*
18862. *De Jerusalem.*
18863. *Nebian.*
18864. *Vigasotte Bianco.*
18865. *Grise Savantine bifere.*
18866. *Quarteria.*
18867. *Douro Vebra.*
18868. *Reculver.*
18869. *Gourand Rouge.*
18870. *D'Agen.*
18871. *Lampa.*
18872. *Large Black Douro.*
18873. *Adam.*
18874. *De Constantine.*
18875. *Biberavo.*
18876. *Grosse Verte.*
18877. *Violette Sepor.*
18878. *Dr. Hoggs Clare.*
18879. *Hardy Prolific.*
18880. *Figue d'Or.*
18881. *Recousse noire.*
18882. *Black Douro.*
18883. *Grassale.*
18884. *Martinique.*
18885. *Crave.*
18886. *White Isohia.*
18887. *Brown Turkey.*
18888. *Pastiliere.*
18889. *Negro Largo.*
18890. *De La Madeleine.*
18891. *Col de Signora Bianco.*
18892. *Dorce Nobis.*
18893. *Pingo de Mel.*
18894. *Black Ischia.*
18895. *Toulousienne.*
18896. *Gouraud Noir.*
18897. *Dorce.*
18898. *Branswick.*
18899. *Gentile.*
18900. *White Adriatic.*
18901. *Pacific white.*
18902. *Vendome.*
18903. *Barbillonne.*
18904. *Figuires Blanch.*
18905. *Warren's Brown Turkey.*
18906. *Capri Milco.*
18907. *Trojano.*
18908. *Capri Solms No. 1.*
18909. *Capri Solms No. 2.*
18910. *Capri Solms No. 3.*
18911. *Capri Solms No. 4.*
18912. *Dauphine.*

18913. TRIFOLIUM PRATENSE. **Red clover.**

From Emilia, Italy. Presented by William G. Scarlett & Co., Baltimore, Md. Received in April, 1906.

18914. PINUS KORAIENSIS (?). **Pine.**

From Manchuria. Presented by the Yokohama Nursery Company, Yokohama, Japan. Received July 5, 1905.

Seed of a 5-needled pine obtained at the base of Heirai Mountain, Manchuria.

18915 to 18921. ORYZA SATIVA. **Rice.**

From Cairo, Egypt. Received through Mr. George P. Foaden, secretary of the Khedivial Agricultural Society, July 5, 1906.

18915. *Ein el Beat.*
18916. *Sina.*
18917. *Italien Ranghino.*
18918. *Fino.*
18919. *Agemi.*
18920. *Sultani.*
18921. *Japonais.*

18922 and 18923.

From Kashgar, Eastern Turkestan. Presented by Rev. P. J. P. Hendriks. Received July 20, 1906.

18922. HORDEUM VULGARE. **Barley.**

"A variety which is said to require only one month without frost. Grown in the mountain regions near Kashgar, Eastern Turkestan." (*Hendriks.*)

18923. RICINUS COMMUNIS. **Castor-oil plant.**

Seed of a medium-sized variety.

18924. MANGIFERA INDICA. **Mango.**

From Miami, Fla. Received through the Subtropical Laboratory and Garden, July 23, 1906.

Turpentine. Seed for growing stocks upon which to inarch standard varieties.

18925. ANONA CHERIMOLIA. **Cherimoyer.**

From Salta Province, Argentina. Presented by Mr. Ernest Nelson, of Sharon, Mass. Received July 13, 1906.

18926 to 18940. ANDROPOGON SORGHUM. **Sorghum.**

From Chillicothe, Tex. Grown in 1905 at the Government Farm, and distributed from same place.

18926. *Djougara balki.* Grown from Agrost. No. 1579.

18927. *Planter's Friend.* Grown from Agrost. No. 1604.

18928. *Amber.* Grown from Agrost. No. 1606.

18929. *Amber.* Grown from Agrost. No. 1658.

18930. *Planter's Friend.* Grown from Agrost. No. 1659.

18931. *Amber.* Grown from Agrost. No. 1747.

18932. *Black-seeded.* Grown from Agrost. No. 2114.

18933. *Edra.* Grown from S. P. I. No. 8815.

18934. *Dshugara Balcha.* Grown from S. P. I. No. 9796.

18935. *Dagdi Jowar.* Grown from S. P. I. No. 9856.

18936. *Djugara.* Grown from S. P. I. No. 10612.

18937. *White.* Grown from S. P. I. No. 13317.

18938. *Red.* Grown from S. P. I. No. 13318.

18939. *Gare.* Grown from S. P. I. No. 14504.

18940. *White of Rey Barelly.* Grown from S. P. I. No. 14635.

18941. LATHYRUS SATIVUS. **Bitter vetch.**

From Clarinda, Iowa. Received through the A. A. Berry Seed Company, July 27, 1906.

18942 to 19057.

From Mexico and southwestern United States. Collected by Mr. David Griffiths, of this Department, and forwarded to the Plant Introduction Garden, Chico, Cal., during the summer of 1905.

The numbers in parentheses are those of Mr. Griffiths.

18942. OPUNTIA sp. **Tuna.**

From El Paso, Tex. (8020.)

18942 to 19057—Continued.

18943. OPUNTIA sp. **Tuna.**

From El Paso, Tex. (8021.)

18944. NOPALEA sp.

From San Mateo, Mexico. (8027.)

18945. OPUNTIA sp. **Tuna.**

Nopal cristilena. From Cardenas, Mexico. (8030.)

18946 to 19057. OPUNTIA sp. **Tuna.**

18946. From Cardenas, Mexico. (8031.)

18947. From Cardenas, Mexico. (8032.)

18948. From San Luis Potosi, Mexico. (8034.)

18949. From San Luis Potosi, Mexico. (8035.)

18950. *Nopal Cuijo.* From San Luis Potosi, Mexico. (8036.)

18951. *Nopal ranchero.* From San Luis Potosi, Mexico. (8037.)

18952. *Nopal palmito.* From San Luis Potosi, Mexico. (8038.)

18953. From San Luis Potosi, Mexico. (8039.)

18954. *Nopal camueso.* From San Luis Potosi, Mexico. (8040.)

18955. From San Luis Potosi, Mexico. (8041.)

18956. From San Luis Potosi, Mexico. (8042.)

18957. *Nopal tapon.* From San Luis Potosi, Mexico. (8043.)

18958. *Nopal.* From San Luis Potosi, Mexico. (8044.)

18959. *Tuna castilla blanca.* From San Luis Potosi, Mexico. (8045.)

18960. *Nopal charol.* From San Luis Potosi, Mexico. (8046.)

18961. From San Luis Potosi, Mexico. (8047.)

18962. From San Luis Potosi, Mexico. (8048.)

18963. *Nopal jocoquillo.* From San Luis Potosi, Mexico. (8049.)

18964. From San Luis Potosi, Mexico. (8050.)

18965. From Alonzo, Mexico. (8053.)

18966. From Alonzo, Mexico. (8055.)

18967. From San Luis Potosi, Mexico. (8058.)

18968. *Nopal jarrillo.* From San Luis Potosi, Mexico. (8061.)

18969. From San Luis Potosi, Mexico. (8062.)

18970. From San Luis Potosi, Mexico. (8063.)

18971. From San Luis Potosi, Mexico. (8064.)

18972. *Nopal cardon blanco.* From Hepasote, Mexico. (8067.)

18973. *Nopal opalillo.* From Hepasote, Mexico. (8068.)

18974. *Tuna amarilla blanca.* From Hepasote, Mexico. (8069.)

18975. From Hepasote, Mexico. (8071.)

18976. From Hepasote, Mexico. (8072.)

18977 *Mameya.* From Hepasote, Mexico. (8073.)

18978. From Hepasote, Mexico. (8074.)

18979. *Nopal San Juanero.* From Hepasote, Mexico. (8075.)

18980. *Nopal loco.* From Hepasote, Mexico. (8076.)

18981. From Hepasote, Mexico. (8077.)

18942 to 19057—Continued.

18982. *Nopal blanco liso.* From Hacienda Los Campos, Mexico. (8079.)
18983. *Nopal durasnillo.* From Aguascalientes, Mexico. (8081.)
18984. *Nopal durasnillo.* From Aguascalientes, Mexico. (8082.)
18985. From Aguascalientes, Mexico. (8083.)
18986. *Nopal joconoxtle.* From Aguascalientes, Mexico. (8084.)
18987. *Nopal joconoxtle.* From Aguascalientes, Mexico. (8086.)
18988. From Aguascalientes, Mexico. (8087.)
18989. From Aguascalientes, Mexico. (8088.)
18990. *Nopal joconoxtle.* From Aguascalientes, Mexico. (8089.)
18991. From Aguascalientes, Mexico. (8090.)
18992. From Aguascalientes, Mexico. (8091.)
18993. *Nopal tapon.* From Aguascalientes, Mexico. (8092.)
18994. *Spineless.* From Aguascalientes, Mexico. (8094.)
18995. From Aguascalientes, Mexico. (8101.)
18996. From Encarnacion, Mexico. (8102.)
18997. *Nopal liso.* From Encarnacion, Mexico. (8103.)
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U. S. DEPARTMENT OF AGRICULTURE.
BUREAU OF PLANT INDUSTRY—BULLETIN NO. 107.
B. T. GALLOWAY, *Chief of Bureau.*

AMERICAN ROOT DRUGS.

BY

ALICE HENKEL.
ASSISTANT, DRUG-PLANT INVESTIGATIONS.

ISSUED OCTOBER 25, 1907.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1907.

BULLETINS OF THE BUREAU OF PLANT INDUSTRY.

The scientific and technical publications of the Bureau of Plant Industry, which was organized July 1, 1901, are issued in a single series of bulletins, a list of which follows.

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U. S. DEPARTMENT OF AGRICULTURE.

BUREAU OF PLANT INDUSTRY—BULLETIN NO. 107.

B. T. GALLOWAY, *Chief of Bureau.*

AMERICAN ROOT DRUGS.

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NEW YORK
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BY

ALICE HENKEL,

ASSISTANT, DRUG-PLANT INVESTIGATIONS.

ISSUED OCTOBER 25, 1907.

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LETTER OF TRANSMITTAL.

U. S. Department of Agriculture,
Bureau of Plant Industry,
Office of the Chief,
Washington, D. C., April 16, 1907.

Sir: I have the honor to transmit herewith and to recommend for publication as Bulletin No. 107 of the series of this Bureau the accompanying manuscript, entitled "American Root Drugs." This paper was prepared by Miss Alice Henkel, Assistant in Drug-Plant Investigations, and has been submitted by the Physiologist in charge with a view to its publication.

The fifty drugs described include all the "official" roots found in this country, besides such "nonofficial" drugs as are most frequently quoted in drug catalogues.

There is a steady demand for information concerning the medicinal plants of this country, and this bulletin on American root drugs has been prepared as a first installment on the subject. It is intended as a guide and reference book for farmers, drug collectors, druggists, students, and others who may be interested in one way or another in the collection or study of our medicinal flora.

Respectfully,

B. T. Galloway,
Chief of Bureau.

Hon. James Wilson,
Secretary of Agriculture.

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AMERICAN ROOT DRUGS.

INTRODUCTION.

More than half of the root drugs recognized in the Eighth Decennial Revision of the United States Pharmacopœia occur in this country, some native and not growing elsewhere and others introduced. All of the official root drugs found in the United States have been included in this bulletin, as well as such native and introduced "nonofficial" roots (those not at present recognized in the United States Pharmacopœia) as seemed to be most generally quoted in the trade lists of the country, the total number of root drugs described being 50. While the most important root drugs thus given are limited to 50, there are included under each of these, wherever required, brief descriptions of related species. It would be impossible to include within the limits of this paper all of the root drugs that are used in this country, but the aim has been to give information concerning those which seem to be the most important commercially, according to the numerous drug lists that have been consulted.

All of the root drugs herein mentioned occur in quantities sufficient for commercial purposes, but the roots of many of the species that also occur in other countries are nevertheless largely imported.

In speaking of "root drugs" in this paper only those are included of which the underground portion is found in commerce, whether in the form of root, rootstock, bulb, or corm, excluding the roots that are used solely for their bark or for their gums or resins.

Except in the botanical descriptions, the term "roots" is generally used, regardless of the fact that the part under consideration may be a rootstock, root, or bulb. In this the commercial practice is followed, which makes no distinction as to the form of the underground portion as classified by botanists, but catalogues them all under the general term "roots."

The medicinal uses are referred to in only the briefest and most general manner, for it is clearly not within the province of a publication of this character to go into details regarding these matters. The statements made are based on the information contained in various dispensatories and other works relating to materia medica.

The illustrations are for the most part made from a collection of photographs taken from nature by C. L. Lochman. A few have

been taken from various publications, mention of which is made under the illustrations in question.

THE COLLECTION OF ROOT DRUGS.

Generally speaking, the roots of annual plants should be dug just before flowering, and those of biennial or perennial plants late in autumn or early in spring, the object being to collect them at a period when there is a cessation of growth; for besides shrinking more and weighing less if collected during the growing season, they are also deficient in medicinal properties. Very frequently a drug is of inferior quality simply because the collector has neglected to gather it in the proper season.

It is unfortunate that so much confusion exists with regard to the common names of American plants. The common name of a plant in one locality may be the same as that of an entirely different plant in another locality, and on account of this confusion the collector is not always sure of the identity of the plant he is collecting, nor the drug dealer as to what he will receive, unless a sample is submitted to him. If more care were exercised in this respect it would mean a saving of time and money to both collector and dealer.

Another important matter that the collector sometimes overlooks is the proper cleaning and drying of the roots. To insure a good market for his crude drugs the collector should be certain not only that he has the right plant, but that it is collected at the proper season of the year, and that he has a clean and thoroughly dried article.

After the roots have been dug they should be freed from dirt and all foreign particles, such as stones and bits of other plants. If the adherent soil can not be removed by shaking the roots, they may, in most instances, be washed in clean water, after which they should be carefully dried. In some cases the roots are sliced or split when green in order to facilitate drying, and wherever this is necessary it will be indicated under the descriptions of the different plants.

For the purpose of drying, the roots should be spread out in thin layers on racks or shelves, or on clean, well-ventilated barn floors or lofts, exposed to light and air but not direct sunlight, and turned occasionally each day until thoroughly dry. If the roots are dried out of doors, they should be placed under shelter at night or upon the approach of damp or rainy weather. Thoroughly dried roots snap readily when bent, and it requires from three to six weeks to cure roots, depending upon the weather conditions and the character of the roots.

Burlap or gunny sacks, or dry, clean barrels may be used for packing the roots for shipment.

The collector should always communicate with the dealers concerning the drugs to be disposed of, sending them a representative sample, plainly marked as to contents, with the name and address of the sender, and stating how large a quantity can be furnished.

The prices per pound mentioned in this bulletin will serve to give the collector an idea as to what he may expect to receive from dealers, but, as with other commodities, depending for their prices upon supply and demand, fluctuations are likely to occur from year to year. An increased demand or a shortage will send prices upward and stimulate collection, which in turn may result in glutting the market, and a decline in prices naturally follows. It is possible, therefore, to give only an approximate range of prices.

PLANTS FURNISHING ROOT DRUGS.

Under each plant will be found synonyms and pharmacopœial name, if any, the common names, habitat, range, descriptions of the plant and root, and information concerning collection, prices, and uses, while in the case of goldenseal and ginseng the methods of culture are included.

MALE-FERN.

(1) *Dryopteris filix-mas* (L.) Schott and (2) *Dryopteris marginalis* (L.) A. Gray.

Synonyms.—(1) *Aspidium filix-mas* Sw. (2) *Aspidium marginale* Sw.

Pharmacopœial name.—Aspidium.

Other common names.—(1) Male shield-fern, sweet brake, knotty brake, basket-fern, bear's-paw root; (2) marginal-fruited shield-fern, evergreen wood-fern.

Habitat and range.—These ferns are found in rocky woods, the male shield-fern inhabiting the region from Canada westward to the Rocky Mountains and Arizona. It is widely distributed also through Europe, northern Asia, northern Africa, and South America. The marginal-fruited shield-fern (Pl. I, fig. 1), one of our most common ferns, occurs from Canada southward to Alabama and Arkansas.

Description of plants.—Both of these species are tall, handsome ferns, the long, erect fronds, or leaves, arising from a chaffy, scaly base, and consisting of numerous crowded stemless leaflets, which are variously divided and notched. There is but little difference between these two species. The male shield-fern is perhaps a trifle stouter, the leaves growing about 3 feet in length and having a bright-green color, whereas the marginal-fruited shield-fern has lighter green leaves, about 2½ feet in length, and is of more slender appearance. The principal difference, however, is found in the arrangement of the "sori," or "fruit dots." These are the very small, round, tawny dots that are found on the backs of fern leaves, and in the male shield-fern these will be found arranged in short rows near the midrib, while in the marginal-fruited shield-fern, as this name indicates, the fruit dots are placed on the margins of the fronds. Both plants are perennials and members of the fern family (Polypodiaceæ).

Description of the rootstock.—These ferns have stout ascending or erect chaffy rootstalks, or rhizomes (Pl. I, fig. 1) as they are technically known. As taken from the ground the rootstock is from 6 to 12 inches in length and 1 to 2 inches thick, covered with closely overlapping, brown, slightly curved stipe bases or leaf bases and soft, brown, chaffy scales. The inside of the rootstock is pale green. As found in the stores, however, male-fern with the stipe bases and roots removed measures about 3 to 6 inches in length and about one-half to 1 inch in thickness, rough where the stipe bases have been removed, brown outside, pale green and rather spongy inside.

The stipe bases remain green for a very long period, and these small, claw-shaped, furrowed portions, or "fingers" as they are called, form a large proportion of the drug found on the American market and, in fact, are said to have largely superseded the rootstock. Male-fern has a disagreeable odor, and the taste is described as bitter-sweet, astringent, acrid, and nauseous.

Collection, prices, and uses.—The best time for collecting male-fern root is from July to September. The root should be carefully cleaned, but not washed, dried out of doors in the shade as quickly as possible, and shipped to druggists at once. The United States Pharmacopœia directs that "the chaff, together with the dead portions of the rhizome and stipes, should be removed, and only such portions used as have retained their internal green color."

Great care is necessary in the preservation of this drug in order to prevent it from deteriorating. If kept too long, its activity will be impaired, and it is said that it will retain its qualities much longer if it is not peeled until required for use. The unreliability sometimes attributed to this drug can in most instances be traced to the presence of the rootstocks of other ferns with which it is often adulterated, or it will be found to be due to improper storing or to the length of time that it has been kept.

The prices paid for male-fern root range from 5 to 10 cents a pound.

Male-fern, official in the United States Pharmacopœia, has been used since the remotest times as a remedy for worms. Grave results are sometimes caused by overdoses.

COUCH-GRASS.

Agropyron repens (L.) Beauv.

Synonym.—*Triticum repens* L.

Pharmacopœial name.—Triticum.

Other common names.—Dog-grass, quick-grass, quack-grass, quitch-grass, quake-grass, scutch-grass, twitch-grass, witch-grass, wheat-grass, creeping wheat-grass, devil's-grass, durfa-grass, Durfee-grass, Dutch-grass, Fin's-grass, Chandler's-grass.

Habitat and range.—Like many of our weeds, couch-grass was introduced from Europe, and is now one of the worst pests the farmer has to contend with, taking possession of cultivated ground and crowding out valuable crops. It occurs most abundantly from Maine to Maryland, westward to Minnesota and Missouri, and is spreading on farms on the Pacific slope, but is rather sparingly distributed in the South.

Description of plant.—Couch-grass is rather coarse, 1 to 3 feet high, and when in flower very much resembles rye or beardless wheat (fig. 1). Several round, smooth, hollow stems, thickened at the joints, are produced from the long, creeping, jointed rootstock. The stems bear 5 to 7 leaves from 3 to 12 inches long, rough on the upper surface and smooth beneath, while the long, cleft leaf sheaths are smooth. The solitary terminal flowering heads or spikes

are compressed, and consist of two rows of spikelets on a wavy and flattened axis. These heads are produced from July to September. Couch-grass belongs to the grass family (Poaceæ).

Description of rootstock.—The pale-yellow, smooth rootstock is long, tough, and jointed, creeping along underneath the ground and pushing in every direction. As found in the stores, it consists of short, angular pieces, from one-eighth to one-fourth of an inch long, of a shining straw color, and hollow. These pieces are odorless, but have a somewhat sweetish taste.

Collection, prices, and uses.—Couch-grass, which is official in the United States Pharmacopœia, should be collected in spring, carefully cleaned, and the rootlets removed. The rootstock (not the rootlets) is then cut into short pieces, about two-fifths of an inch in length, for which purpose an ordinary feed-cutting machine may be used, and thoroughly dried.

Couch-grass is usually destroyed by plowing up and burning, for if any of the joints are permitted to remain in the soil new plants will be produced. But, instead of burning, the rootstocks may be saved and prepared for the drug market in the manner above stated. The prices range from 3 to 5 cents a pound. At present couch-grass is collected chiefly in Europe.

A fluid extract is prepared from couch-grass, which is used in affections of the kidney and bladder.

FIG. 1.—Couch-grass (*Agropyron repens*).

WILD TURNIP.

Arisæma triphyllum (L.) Torr.

Synonym.—*Arum triphyllum* L.

Other common names.—Arum, three-leaved arum, Indian turnip, jack-in-the-pulpit, wake-robin, wild pepper, dragon-turnip, brown dragon, devil's-ear, marsh-turnip, swamp-turnip, meadow-turnip, pepper-turnip, starchwort, bog-onion, priest's-pintle, lords-and-ladies.

Habitat and range.—Wild turnip inhabits moist woods from Canada to Florida and westward to Kansas and Minnesota.

Description of plant.—Early in April the quaint green and brownish purple hooded flowers of the wild turnip may be seen in the shady depths of the woods.

It is a perennial plant belonging to the arum family (Araceæ), and reaches a height of from 10 inches to 3 feet. The leaves, of which there are only one or two, unfold with the flowers; they are borne on long, erect, sheathing stalks,

and consist of three smooth, oval leaflets; the latter are 3 to 6 inches long, and from 1½ to 3½ inches wide, net veined, and with one vein running parallel with the margins. The "flower" is curiously formed, somewhat like the calla lily, consisting of what is known botanically as a spathe, within which is inclosed the spadix. The spathe is an oval, leaflike part, the lower portion of which, in the flower under consideration, is rolled together so as to form a tube, while the upper, pointed part is usually bent forward, thus forming a flap or hood over the tube-shaped part which contains the spadix. (Fig. 2.) In fact it is very similar to the familiar flower of the calla lily of the gardens, except that, instead of being white, the wild turnip is either all green or striped with very dark purple, sometimes seeming almost black, and in the calla lily the "flap" is turned back, whereas in the wild turnip it is bent forward over the tube. Inside of the spathe is the spadix, also green or purple, which is club shaped, rounded at the summit, and narrowly contracted at the base, where it is surrounded by either the male or female flowers or both, in the latter case (the most infrequent) the male flowers being placed below the female flowers. In autumn the fruit ripens in the form of a bunch of bright scarlet, shining berries. The entire plant is acrid, but the root more especially so.

FIG. 2.—Wild turnip (*Arisæma triphyllum*).

Description of "root."—The underground portion of this plant is known botanically as a "corm," and is somewhat globular and shaped like a turnip. The lower part of the corm is flat and wrinkled, while the upper part is surrounded by coarse, wavy rootlets. The outside is brownish gray and the inside white and mealy. It has no odor, but an intensely acrid, burning taste, and to those who may have been induced in their school days to taste of this root wild turnip will be familiar chiefly on account of its never-to-be-forgotten acrid, indeed caustic, properties. The dried article of commerce consists of round, white slices, with brown edges, only slightly shrunken, and breaking with a starchy fracture.

Collection, prices, and uses.—The partially dried corm is used in medicine. It is dug in summer, transversely sliced, and dried. When first dug it is intensely acrid, but drying and heat diminish the acridity. It loses its acridity rapidly with age. Wild turnip brings from 7 to 10 cents a pound.

The corm of wild turnip, which was official in the United States Pharmacopœia from 1820 to 1870, is used as a stimulant, diaphoretic, expectorant, and irritant.

SKUNK-CABBAGE.

Spathyema foetida (L.) Raf.

Synonyms.—*Dracontium foetidum* L.; *Symplocarpus foetidus* Nutt.

Other common names.—Dracontium, skunkweed, polecat-weed, swamp-cabbage, meadow-cabbage, collard, fetid hellebore, stinking poke, pockweed.

Habitat and range.—Swamps and other wet places from Canada to Florida, Iowa, and Minnesota abound with this ill-smelling herb.

Description of plant.—Most of the common names applied to this plant, as well as the scientific names, are indicative of the most striking characteristic of this early spring visitor, namely, the rank, offensive, carrion odor that emanates from it. Skunk-cabbage is one of the very earliest of our spring flowers, appearing in February or March, but it is safe to say that it is not likely to suffer extermination at the hands of the enthusiastic gatherer of spring flowers. In the latitude of Washington skunk-cabbage has been known to be in flower in December.

It is a curious plant, with its hood-shaped, purplish striped flowers appearing before the leaves. It belongs to the arum family (Araceæ) and is a perennial. The "flower" is in the form of a thick, ovate, swollen spathe, about 3 to 6 inches in height, the top pointed and curved inward, spotted and striped with purple and yellowish green. The spathe is not open like that of the wild turnip or calla lily, to which family this plant also belongs, but the edges are rolled inward, completely hiding the spadix. In this plant the spadix is not spike-like, as in the wild turnip, but is generally somewhat globular, entirely covered with the numerous, dull-purple flowers. (Pl. I, fig. 2.) After the fruit has ripened the spadix will be found to have grown considerably, the spathe meantime having decayed.

The leaves, which appear after the flower, are numerous and very large, about 1 to 3 feet in length and about 1 foot in width; they are thin in texture, but prominently nerved with fleshy nerves, and are borne on deeply channeled stems.

Description of rootstock.—Skunk-cabbage has a thick, straight, reddish brown rootstock, from 3 to 5 inches long, and about 2 inches in diameter, and having a whorl of crowded fleshy roots (Pl. I, fig. 2) which penetrate the soil to considerable depth. The dried article of commerce consists of either the entire rootstock and roots, which are dark brown and wrinkled on the outside, whitish and starchy within, or of very much compressed, wrinkled, transverse slices. When bruised, the root has the characteristic fetid odor of the plant and possesses a sharp acrid taste, both of which become less the longer the root is kept.

Collection, prices, and uses.—The rootstock of skunk-cabbage should be collected early in spring, soon after the appearance of the flower, or after the seeds have ripened, in August or September. It should be carefully dried, either in its entire state or deprived of the roots and cut into transverse slices. Skunk-cabbage loses its odor and acridity with age, and should therefore not be kept longer than one season. The range of prices is from 4 to 7 cents a pound.

Skunk-cabbage, official from 1820 to 1880, is used in affections of the respiratory organs, in nervous disorders, rheumatism, and dropsical complaints.

SWEET-FLAG.

Acorus calamus L.

Pharmacopœial name.—Calamus.

Other common names.—Sweet cane, sweet grass, sweet myrtle, sweet rush, sweet sedge, sweet segg, sweetroot, cinnamon-sedge, myrtle-flag, myrtle-grass, myrtle-sedge, beewort.

Habitat and range.—This plant frequents wet and muddy places and borders of streams from Nova Scotia to Minnesota, southward to Florida and Texas, also occurring in Europe and Asia. It is usually partly immersed in water, and is generally found in company with the cat-tail and other water-loving species of flag.

Description of plant.—The swordlike leaves of the sweet-flag resemble those of other flags so much that before the plant is in flower it is difficult to recognize simply by the appearance of its leaves. The leaves of the blue flag or "poison-flag," as it has been called, are very similar to those of the sweet-flag, and this resemblance often leads to cases of poisoning among children who thus mistake one for the other. However, as the leaves of the sweet-flag are fragrant, the odor will be a means of recognizing it. Of course when the sweet-flag is in flower the identification of the plant is easy.

The sheathing leaves of this native perennial, which belongs to the arum family (Araceæ), are from 2 to 6 feet in height and about 1 inch in width; they are sharp pointed and have a ridged midrib running their entire length. The flowering head, produced from the side of the stalk, consists of a fleshy spike sometimes 3½ inches long and about one-half inch in thickness, closely covered with very small greenish yellow flowers, which appear from May to July. (Pl. I, fig. 3.)

Description of rootstock.—The long, creeping rootstock of the sweet-flag is thick and fleshy, somewhat spongy, and producing numerous rootlets. (Pl. I, fig. 3.) The odor is very aromatic and agreeable, and the taste pungent and bitter. The dried article, as found in the stores, consists of entire or split pieces of various lengths, from 3 to 6 inches, light brown on the outside with blackish spots, sharply wrinkled lengthwise, the upper surface marked obliquely with dark leaf scars, and the lower surface showing many small circular scars, which, at first glance, give one the impression that the root is worm-eaten, but which are the remains of rootlets that have been removed from the rootstock. Internally the rootstock is whitish and of a spongy texture. The aromatic odor and pungent, bitter taste are retained in the dried article.

Collection, prices, and uses.—The United States Pharmacopœia directs that the unpeeled rhizome, or rootstock, be used. It is collected either in early spring or late in autumn. It is pulled or grubbed from the soft earth, freed from adhering dirt, and the rootlets removed, as these are not so aromatic and more bitter. The rootstock is then carefully dried, sometimes by means of moderate heat. Sweet-flag deteriorates with age and is subject to the attacks of worms. It loses about three-fourths of its weight in drying.

Some of the sweet-flag root found in commerce consists of handsome white pieces. These usually come from Germany, and have been peeled before drying, but they are not so strong and aromatic as the unpeeled roots. Unpeeled sweet-flag root brings from 3 to 6 cents a pound.

Sweet-flag is employed as an aromatic stimulant and tonic in feeble digestion. The dried root is frequently chewed for the relief of dyspepsia.

CHAMAELIRIUM, OR HELONIAS.

Chamaelirium luteum (L.) A. Gray.

Synonym.—Helonias dioica Pursh.

Other common names.—Unicorn-root, false unicorn-root, blazingstar, drooping starwort, starwort, devil's-bit, unicorn's-horn.

In order to avoid the existing confusion of common names of this plant, it is most desirable to use the scientific names Chamaelirium or Helonias exclusively. Chamaelirium is the most recent botanical designation and will be used throughout this article, but the synonym Helonias is a name very frequently employed by the drug trade. The plant with which it is so much confused, *Aletris farinosa*, will also be designated throughout by its generic name, Aletris.

Habitat and range.—This native plant is found in open woods from Massachusetts to Michigan, south to Florida and Arkansas.

Description of plant.—Chamaelirium and Aletris (*Aletris farinosa*) have long been confused by drug collectors and others, owing undoubtedly to the transposition of some of their similar common names, such as "starwort" and "stargrass." The plants can scarcely be said to resemble each other, however, except perhaps in their general habit of growth. (See Pl. II, figs. 1 and 2.)

The male and female flowers of Chamaelirium are borne on separate plants, and in this respect are entirely different from Aletris; neither do the flowers resemble those of Aletris.

Chamaelirium is an erect, somewhat fleshy herb, perennial, and belongs to the bunchflower family (Melanthiaceæ). The male plant grows to a height of from 1½ to 2½ feet, and the female plant is sometimes 4 feet tall and is also more leafy.

The plants have both basal and stem leaves, whereas Aletris has only the basal leaves. The basal leaves of Chamaelirium are broad and blunt at the top, narrowing toward the base into a long stem; they are sometimes so much broadened at the top that they may be characterized as spoon shaped, and are from 2 to 8 inches long and from one-half to 1½ inches wide. The stem leaves are lance shaped and sharp pointed, on short stems or stemless. (Pl. II, fig. 1.)

The white starry flowers of Chamaelirium are produced from June to July, those of the male plant being borne in nodding, graceful, plumelike spikes 3 to 9 inches long (Pl. II, fig. 1) and those of the female plant in erect spikes. The many-seeded capsule is oblong, opening by three valves at the apex.

Another species is now recognized, *Chamaelirium obovale* Small, which seems to differ chiefly in having larger flowers and obovoid capsules.

Description of rootstock.—The rootstock of Chamaelirium does not in the least resemble that of Aletris, with which it is so generally confused. It is from one-half to 2 inches in length, generally curved upward at one end in the form of a horn (whence the common name, "unicorn") and having the appearance of having been bitten off. (Pl. II, fig. 1.) It is of a dark-brown color, with fine transverse wrinkles, rough, on the upper surface showing a few stem scars, and giving off from all sides numerous brown fibrous rootlets. The more recent rootlets have a soft outer covering, which in the older rootlets has worn away, leaving the fine but tough and woody whitish center. The rootlets penetrate to the central part of the rootstock, and this serves as a distinguishing character from Aletris, as a transverse section of Chamaelirium very plainly shows these fibers extending some distance within the rootstock. Furthermore, the rootstock of Chamaelirium exhibits a number of small holes wherever these rootlets

have broken off, giving it the appearance of having become "wormy." It is hard and horny within and has a peculiar odor and a very bitter, disagreeable taste, whereas Aletris is not at all bitter.

Collection, prices, and uses.—Chamaelirium should be collected in autumn. The prices paid to collectors may be said to range from about 30 to 45 cents a pound. In the fall of 1906 a scarcity of this root was reported. As already indicated, Chamaelirium and Aletris are often gathered and mistaken for each other by collectors, but, as will be seen from the preceding description, there is really no excuse for such error.

From the confusion that has existed properties peculiar to the one plant have also been attributed to the other, but it seems now generally agreed that Chamaelirium is of use especially as a tonic in derangements of women.

AMERICAN HELLEBORE.

Veratrum viride Ait.

Pharmacopœial name.—Veratrum.

Other common names.—True veratrum, green veratrum, American veratrum, green hellebore, swamp-hellebore, big hellebore, false hellebore, bear-corn, bugbane, bugwort, devil's-bite, earth-gall, Indian poke, itchweed, tickleweed, duckretter.

Habitat and range.—American hellebore is native in rich wet woods, swamps, and wet meadows, its range extending from Canada, Alaska, and Minnesota south to Georgia.

Description of plant.—Early in spring, usually in company with the skunk-cabbage, the large, bright-green leaves of American hellebore make their way through the soil, their straight, erect leaf spears forming a conspicuous feature of the yet scanty spring vegetation. Later in the season a stout and erect leafy stem is sent up, sometimes growing as tall as 6 feet. It is solid and round, pale green, very leafy, and closely surrounded by the sheathing bases of the leaves, unbranched except in the flowering head. The leaves are hairy, prominently nerved, folded or pleated like a fan. They have no stems, but their bases encircle or sheathe the main stalk, and are very large, especially the lower ones, which are from 6 to 12 inches in length, from 3 to 6 inches in width, and broadly oval. As they approach the top of the plant the leaves become narrower. The flowers, which appear from May to July, are greenish yellow and numerous, and are borne in rather open clusters. American hellebore belongs to the bunchflower family (Melanthiaceæ) and is a perennial.

This species is a very near relative of the European white hellebore (*Veratrum album* L.), and in fact has by some been regarded as identical with it, or at least as a variety of it. It is taller than *V. album* and has narrower leaves and greener flowers. Both species are official in the United States Pharmacopœia.

Description of rootstock.—The fresh rootstock of American hellebore is ovoid or obconical, upright, thick, and fleshy, the upper part of it arranged in layers, the lower part of it more solid, and producing numerous whitish roots from all sides. In the fresh state it has a rather strong, disagreeable odor. As found in commerce, American hellebore rootstock is sometimes entire, but more generally sliced, and is of a light-brown or dark-brown color externally and internally yellowish white; the roots, which are from 4 to 8 inches long, have a shriveled appearance, and are brown or yellowish. There is no odor to the

dried rootstock, but when powdered it causes violent sneezing. The rootstock, which has a bitter and very acrid taste, is poisonous.

Collection, prices, and uses.—American hellebore should be dug in autumn after the leaves have died, and washed and carefully dried, either in the whole state or sliced in various ways. It deteriorates with age, and should therefore not be kept longer than a year.

The adulterations sometimes met with are the rootstocks of related plants, and the skunk-cabbage is also occasionally found mixed with it, but this is probably unintentional, as the two plants usually grow close together.

Collectors of American hellebore root receive from about 3 to 10 cents a pound.

American hellebore, official in the United States Pharmacopœia, is an acrid, narcotic poison, and has emetic, diaphoretic, and sedative properties.

FIG. 3.—American hellebore (*Veratrum viride*).

ALETRIS.

Aletris farinosa L.

Other common names.—Stargrass, blazingstar, mealy starwort, starwort, unicorn-root, true unicorn-root, unicorn-plant, unicorn's-horn, colic-root, devil's-bit, ague-grass, ague-root, aloe-root, crow-corn, huskwort.

A glance at these common names will show many that have been applied to other plants, especially to Chamaelirium, with which Aletris is so much confused. In order to guard against this confusion as much as possible, it is best not to use the common names of this plant at all, referring to it only by its generic name, Aletris.

Habit and range.—Aletris occurs in dry, generally sandy soil, from Maine to Minnesota, Florida, and Tennessee.

Description of plant.—As stated under Chamaelirium, this plant is often confused with the former by collectors and others, although there seems to be no good reason why this should be so. The plants do not resemble each other except in habit of growth (see Pl. II, figs. 1 and 2), and the trouble undoubtedly arose from a confusion of the somewhat similar common names of the plants, as, for instance, "stargrass" and "starwort."

Aletris may be at once distinguished by the grasslike leaves, which spread out on the ground in the form of a star, and by the slender spikes of rough, mealy flowers.

This native perennial, belonging to the lily family (Liliaceæ), is an erect, slender herb, 1½ to 3 feet tall, with basal leaves only. These leaves are grasslike, from 2 to 6 inches long, and have a yellowish green or willow-

green color. As already stated, they surround the base of the stem in the form of a star. Instead of stem leaves, there are very small, leaflike bracts placed at some distance apart on the stem. From May to July the erect flowering spike, from 4 to 12 inches long, is produced, bearing white, urn-shaped flowers, sometimes tinged with yellow at the apex, and having a rough, wrinkled and mealy appearance. (Pl. II, fig. 2.) The seed capsule is ovoid, opening by three valves, and containing many seeds. When the flowers in the spike are still in bud, there is a suggestion of resemblance to the female spike of Chamaelirium with its fruit half formed.

Several other species are recognized by botanists, namely, *Aletris aurea* Walt., *A. lutea* Small, and *A. obovata* Nash, but aside from the flowers, which in *aurea* and *lutea* are yellow, and slight variations in form, such as a more contracted perianth, the differences are not so pronounced that the plants would require a detailed description here. They have undoubtedly been collected with *Aletris farinosa* for years, and are sufficiently like it to be readily recognized.

Description of rootstock.—Not only have the plants of Aletris and Chamaelirium been confused, but the rootstocks as well. There is, however, no resemblance between them.

Aletris has a horizontal rootstock from one-half to 1½ inches in length, rough and scaly, and almost completely hidden by the fibrous roots and remains of the basal leaves. Upon close examination the scars of former leaf stems may be seen along the upper surface. The rootlets are from 2 to 10 inches in length, those of recent growth whitish and covered with several layers of epidermis which gradually peel off, and the older rootlets of the rootstock showing this epidermis already scaled off, leaving only the hard, brown, woody center. The rootstock in commerce almost invariably shows at one end a tuft of the remains of the basal leaves, which do not lose their green color. It is grayish brown outside, whitish within, and breaks with a mealy fracture. It has no odor, and a starchy taste, followed by some acridity, *but no bitterness.*

Collection, prices, and uses.—Aletris should be collected in autumn, and there is no reason why collectors should make the common mistake of confusing Aletris with Chamaelirium. By comparing the description of Aletris with that of Chamaelirium, it will be seen that there is scarcely any resemblance. Aletris ranges from 30 to 40 cents a pound.

As indicated under Chamaelirium, the medicinal properties have also been considered the same in both plants, but Aletris is now regarded of value chiefly in digestive troubles. Aletris was official in the United States Pharmacopœia from 1820 to 1870.

BETHROOT.

Trillium erectum L.

Other common names.—Trillium, red trillium, purple trillium, ill-scented trillium, birthroot, birthwort, bathwort, bathflower, red wake-robin, purple wake-robin, ill-scented wake-robin, red-benjamin, bumblebee-root, daffydown-dilly, dishcloth, Indian balm, Indian shamrock, nosebleed, squawflower, squawroot, wood-lily, true-love, orange-blossom. Many of these names are applied also to other species of Trillium.

Habitat and range.—Bethroot is a native plant growing in rich soil in damp, shady woods from Canada south to Tennessee and Missouri.

Description of plant.—This plant is a perennial belonging to the lily-of-the-valley family (Convallariaceæ). It is a low growing plant, from about 8 to 16 inches in height, with a rather stout stem, having three leaves arranged in

a whorl near the top. These leaves are broadly ovate, almost circular in outline, sharp pointed at the apex and narrowed at the base, 3 to 7 inches long and about as wide, and practically stemless.

Not only the leaves of this plant, but the flowers and parts of the flowers are arranged in threes, and this feature will serve to identify the plant. (Pl. I, fig. 4.) The solitary terminal flower of bethroot has three sepals and three petals, both more or less lance shaped and spreading, the former greenish, and the petals, which are 1¼ inches long and one-half inch wide, are sometimes dark purple, pink, greenish, or white. The flower has an unpleasant odor. It appears from April to June and is followed later in the season by an oval, reddish berry.

Various other species of Trillium are used in medicine, possessing properties similar to those of the species under consideration. These are also very similar in appearance to *Trillium erectum*.

Description of root.—Bethroot (Pl. I, fig. 4), as found in the stores, is short and thick, of a light-brown color externally, whitish or yellowish inside, somewhat globular or oblong in shape, and covered all around with numerous pale-brown, shriveled rootlets. The top of the root generally shows a succession of fine circles or rings, and usually bears the remains of stem bases.

The root has a slight odor, and is at first sweetish and astringent, followed by a bitter and acrid taste. When chewed it causes a flow of saliva.

Collection, prices, and uses.—Bethroot is generally collected toward the close of summer. The price ranges from 7 to 10 cents a pound.

It was much esteemed as a remedy among the Indians and early settlers. Its present use is that of an astringent, tonic, and alterative, and also that of an expectorant.

WILD YAM.

Dioscorea villosa L.

Other common names.—Dioscorea, colicroot, rheumatism-root, devil's-bones.

Habitat and range.—Wild yam grows in moist thickets, trailing over adjacent shrubs and bushes, its range extending from Rhode Island to Minnesota, south to Florida and Texas. It is most common in the central and southern portions of the United States.

Description of plant.—This native perennial vine is similar to and belongs to the same family as the well-known cinnamon vine of the gardens—namely, the yam family (Dioscoreaceæ). It attains a length of about 15 feet, the stem smooth, the leaves heart shaped and 2 to 6 inches long by 1 to 4 inches wide.

The leaves, which are borne on long, slender stems, are thin, green, and smooth on the upper surface, paler and rather thickly hairy on the under surface. The small greenish yellow flowers are produced from June to July, the male flowers borne in drooping clusters about 3 to 6 inches long, and the female flowers in drooping spikelike heads. The fruit, which is in the form of a dry, membranous, 3-winged, yellowish green capsule, ripens about September and remains on the vine for some time during the winter. (Pl. II, fig. 3.)

Growing farther south than the species above mentioned is a variety for which the name *glabra* has been suggested.

According to C. G. Lloyd (King's American Dispensatory, Vol. I, 1898), there is a variety of *Dioscorea villosa* the root of which first made its appearance among the true yam roots of commerce, and which was so different in form that it was rejected as an adulteration. The plant, however, from

which the false root was derived was found upon investigation to be almost identical with the true yam, except that the leaves were perfectly smooth, lacking the hairiness on the under surface of the leaf which is characteristic of the true wild yam. The false variety also differs in its habit of growth, not growing in dense clumps like the true wild yam, but generally isolated. The root of the variety, however, is quite distinct from that of the true wild yam, being much more knotty. Lloyd states further that the hairiness or lack of hairiness on the under side of the leaf is a certain indication as to the form of the root.

Lloyd, recognizing the necessity of classifying these two yam roots of commerce, has designated the smooth-leaved variety as *Dioscorea villosa* var. *glabra*.

Description of rootstocks.—The rootstock of the true wild yam (Pl. II, fig. 3) runs horizontally underneath the surface of the ground. As found in commerce, it consists of very hard pieces, 6 inches and sometimes 2 feet in length, but only about one-fourth or one-half of an inch in diameter, twisted, covered with a thin brown bark, whitish within, and showing stem scars almost an inch apart on the upper surface, small protuberances on the sides, and numerous rather wiry rootlets on the lower surface.

The false wild yam, on the other hand, has a much heavier, rough, knotty rootstock, with thick branches from 1 inch to 3 inches long, the upper surface covered with crowded stem scars and the lower side furnished with stout wiry rootlets. Within it is similar to the true yam root.

Collection, prices, and uses.—The roots are generally collected in autumn, and bring from 2½ to 4 cents a pound. Wild yam is said to possess expectorant properties and to promote perspiration, and in large doses proving emetic. It has been employed in bilious colic, and by the negroes in the South in the treatment of muscular rheumatism.

BLUE FLAG.

Iris versicolor L.

Other common names.—Iris, flag-lily, liver-lily, snake-lily, poison-flag, water-flag, American fleur-de-lis or flower-de-luce.

Habitat and range.—Blue flag delights in wet, swampy localities, making its home in marshes, thickets, and wet meadows from Newfoundland to Manitoba, south to Florida and Arkansas.

Description of plant.—The flowers of all of the species belonging to this genus are similar, and are readily recognized by their rather peculiar form, the three outer segments or parts reflexed or turned back and the three inner segments standing erect.

Blue flag is about 2 to 3 feet in height, with an erect stem sometimes branched near the top, and sword-shaped leaves which are shorter than the stem, from one-half to 1 inch in width, showing a slight grayish "bloom," and sheathing at the base. This plant is a perennial belonging to the iris family (Iridaceæ), and is a native of this country. June is generally regarded as the month for the flowering of the blue flag, although it may be said to be in flower from May to July, depending on the locality. The flowers are large and very handsome, each stem bearing from two to six or more. They consist of six segments or parts, the three outer ones turned back and the three inner ones erect and much smaller. (Pl. II, fig. 4.) The flowers are usually purplish blue, the "claw," or narrow base of the segments, variegated with yellow, green, or white and marked with purple veins.

All of the species belonging to this genus are more or less variegated in color; hence the name "iris," meaning "rainbow," and the specific name "versicolor," meaning "various colors." The name "poison-flag" has been applied to it on account of the poisonous effect it has produced in children, who, owing to the close resemblance of the plants before reaching the flowering stage, sometimes mistake it for sweet-flag.

The seed capsule is oblong, about 1½ inches long, and contains numerous seeds.

Description of rootstock.—Blue flag has a thick, fleshy, horizontal rootstock, branched, and producing long fibrous roots. (Pl. II, fig. 4.) It resembles sweet-flag (Calamus), and has been mistaken for it. The sections of the rootstock of blue flag, however, are flattened above and rounded below; the scars of the leaf sheaths are in the form of rings, whereas in sweet-flag the rootstock is cylindrical and the scars left by the leaf sheaths are obliquely transverse. Furthermore, there is a difference in the arrangement of the roots on the rootstock, the scars left by the roots in blue flag being close together generally nearer the larger end, while in sweet-flag the disposition of the roots along the rootstock is quite regular. Blue flag is grayish brown on the outside when dried, and sweet-flag is light brown or fawn colored. Blue flag has no well-marked odor, and the taste is acrid and nauseous, and in sweet-flag there is a pleasant odor and bitter, pungent taste.

Collection, prices, and uses.—Blue flag is collected in autumn, and usually brings from about 7 to 10 cents a pound. Great scarcity of blue flag root was reported from the producing districts in the autumn of 1906. It is an old remedy, the Indians esteeming it highly in stomach troubles, and it is said that it was sometimes cultivated by them in near-by ponds on account of its medicinal value. It has also been used as a domestic remedy, and is regarded as an alterative, diuretic, and purgative. It was official in the United States Pharmacopœia of 1890.

LADY'S-SLIPPER.

(1) *Cypripedium hirsutum* Mill. and (2) *Cypripedium parviflorum* Salisb.

Synonym.—(1) *Cypripedium pubescens* Willd.

Pharmacopœial name.—Cypripedium.

Other common names.—(1) Large yellow lady's-slipper, yellow lady's-slipper, yellow moccasin-flower, Venus'-shoe, Venus'-cup, yellow Indian-shoe, American valerian, nerve-root, male nervine, yellow Noah's-ark, yellows, monkey-flower, umbil-root, yellow umbil; (2) small yellow lady's-slipper.

Habitat and range.—Both of these native species frequent bogs and wet places in deep shady woods and thickets. The large yellow lady's-slipper may be found from Nova Scotia south to Alabama and west to Nebraska and Missouri. The range for the small yellow lady's-slipper extends from Newfoundland south along the mountains to Georgia, and west to Missouri, Washington, and British Columbia.

Description of plants.—The orchid family (Orchidaceæ), to which the lady's-slippers belong, boasts of many beautiful, showy, and curious species, and the lady's-slipper is no exception. There are several other plants to which the name lady's-slipper has been applied, but one glance at the peculiar structure of the flowers in the species under consideration, as shown in the illustration (Pl. III, fig. 1), will enable anyone to recognize them as soon as seen.

The particular species of lady's-slipper under consideration in this article do not differ very materially from each other. Both are perennials, growing from

1 to about 2 feet in height, with rather large leaves and with yellow flowers more or less marked with purple, the main difference being that in *hirsutum* the flower is larger and pale yellow, while in *parviflorum* the flower is small, bright yellow, and perhaps more prominently striped and spotted with purple. The stem, leaves, and inside of corolla or lip are somewhat hairy in the large yellow lady's-slipper, but not in the small yellow lady's-slipper. These hairs are said to be irritating to some people, in whom they cause an eruption of the skin.

The leaves of the lady's-slipper vary in size from 2 to 6 inches in length and from 1 to 3 inches in width, and are broadly oval or elliptic, sharp pointed, with numerous parallel veins, and sheathing at the base, somewhat hairy in the large lady's-slipper. The solitary terminal flower, which appears from May to June, is very showy and curiously formed, the lip being the most prominent part. This lip looks like an inflated bag (1 to 2 inches long in the large lady's-slipper), pale yellow or bright yellow in color, variously striped and blotched with purple. The other parts of the flower are greenish or yellowish, with purple stripes, and the petals are usually twisted.

Description of rootstock.—The rootstock is of horizontal growth, crooked, fleshy, and with numerous wavy, fibrous roots. (Pl. III, fig. 1.) As found in commerce, the rootstocks are from 1 to 4 inches in length, about an eighth of an inch in thickness, dark brown, the upper surface showing numerous round cup-shaped scars, the remains of former annual stems, and the lower surface thickly covered with wavy, wiry, and brittle roots, the latter breaking off with a short, white fracture. The odor is rather heavy and disagreeable, and the taste is described as sweetish, bitter, and somewhat pungent.

Collection, prices, and uses.—Both rootstock and roots are used, and these should be collected in autumn, freed from dirt, and carefully dried in the shade. These beautiful plants are becoming rare in many localities. Sometimes such high-priced drugs as goldenseal and senega are found mixed with the lady's-slipper, but as these are more expensive than the lady's-slipper, it is not likely that they are included with fraudulent intent, and they can be readily distinguished. The prices paid to collectors of this root range from 32 to 35 cents a pound.

The principal use of lady's-slipper, which is official in the United States Pharmacopœia, is as an antispasmodic and nerve tonic, and it has been used for the same purposes as valerian.

CRAWLEY-ROOT.

Corallorhiza odontorhiza (Willd.) Nutt.

Other common names.—Corallorhiza, crawley, coralroot, small coralroot, small-flowered coralroot, late coralroot, dragon's-claw, chickentoe, turkey-claw, feverroot.

Habitat and range.—Rich, shady woods having an abundance of leaf mold produce this curious little plant. It may be found in such situations from Maine to Florida, westward to Michigan and Missouri.

Description of plant.—This peculiar native perennial, belonging to the orchid family (Orchidaceæ), is unlike most other plants, being leafless, and instead of a green stem it has a purplish brown, sheathed scape, somewhat swollen or bulbous at the base and bearing a clustered head of purplish flowers 2 to 4 inches long. It does not grow much taller than about a foot in height. (Fig. 4.)

The flowers, 6 to 20 in a head, appear from July to September, and consist of lance-shaped sepals and petals striped with purple and a broad, whitish,

oval lip, generally marked with purple and narrowed at the base. The seed capsule is large, oblong, or somewhat globular.

Description of rootstock.—The rootstock of this plant is also curious, resembling in its formation a piece of coral (fig. 4), on account of which it is known by the name "coralroot." The other common names, such as chickentoe, turkey-claw, etc., all have reference to the form of the rootstock. As found in commerce, crawley-root consists of small, dark-brown wrinkled pieces, the larger ones branched like coral. The taste at first is sweetish, becoming afterwards slightly bitter. It has a peculiar odor when fresh, but when dry it is without odor.

Collection, prices, and uses.—Crawley-root should be collected in July or August. The price ranges from 20 to 50 cents a pound. Other species of Corallorhiza are sometimes collected and are said to probably possess similar properties. This root is said to be very effective for promoting perspiration, and it is also used as a sedative and in fever.

FIG. 4.—Crawley-root (*Corallorhiza odontorhiza*). After Torrey's Flora of New York.

CANADA SNAKEROOT.

Asarum canadense L.

Other common names.—Asarum, wild ginger, Indian ginger, Vermont snakeroot, heart-snakeroot, southern snakeroot, black snakeroot, colt's-foot snakeroot, black snakeweed, broad-leaved asarabacca, false colt's-foot, cat's-foot, colicroot.

Habitat and range.—This inconspicuous little plant frequents rich woods or rich soil along roadsides from Canada south to North Carolina and Kansas.

Description of plant.—Canada snakeroot is a small, apparently stemless perennial, not more than 6 to 12 inches in height, and belongs to the birthwort family (Aristolochiaceæ). It usually has but two leaves, which are borne on slender, finely hairy stems; they are kidney shaped or heart shaped, thin, dark green above and paler green on the lower surface, strongly veined, and from 4 to 7 inches broad. The solitary bell-shaped flower is of an unassuming dull brown or brownish purple, and this modest color, together with its position on the plant, renders it so inconspicuous as to escape the notice of the casual observer. It droops from a short, slender stalk produced between the two leaf stems and is almost hidden under the two leaves, growing so close to the ground that it is sometimes buried beneath old leaves, and sometimes the soil must be removed before the flower can be seen. It is bell shaped, woolly, the inside darker in color than the outside and of a satiny texture. The fruit which follows is in the form of a leathery 6-celled capsule. (Pl. III, fig. 2.)

Description of rootstock.—Canada snakeroot has a creeping, yellowish rootstock, slightly jointed, with thin rootlets produced from joints which occur about every half inch or so. (Pl. III, fig. 2.) In the drug trade the rootstock is usually found in pieces a few inches in length and about one-eighth of an inch in diameter. These are four-angled, crooked, brownish and wrinkled on the outside, whitish inside and showing a large central pith, hard and brittle, and breaking with a short fracture. The odor is fragrant and the taste spicy

and aromatic, and has been said to be intermediate between ginger and serpentaria.

Collection, prices, and uses.—The aromatic root of Canada snakeroot is collected in autumn, and the price ranges from 10 to 15 cents a pound. It was reported as very scarce in the latter part of the summer of 1906. Canada snakeroot, which was official in the United States Pharmacopœia from 1820 to 1880, is used as an aromatic, diaphoretic, and carminative.

SERPENTARIA.

(1) *Aristolochia serpentaria* L. and (2) *Aristolochia reticulata* Nutt.

Pharmacopœial name.—Serpentaria.

Other common names.—(1) Virginia serpentaria, Virginia snakeroot, serpentary, snakeweed, pelican-flower, snagrel, sangrel, sangree-root; (2) Texas serpentaria, Texas snakeroot, Red River snakeroot.

Habitat and range.—Virginia serpentaria is found in rich woods from Connecticut to Michigan and southward, principally along the Alleghenies, and Texas serpentaria occurs in the Southwestern States, growing along river banks from Arkansas to Louisiana.

Description of Virginia serpentaria.—About midsummer the queerly shaped flowers of this native perennial are produced. They are very similar to those of the better known "Dutchman's-pipe," another species of this genus, which is quite extensively grown as an ornamental vine for covering porches and trellises. Virginia serpentaria and Texas serpentaria both belong to the birthwort family (Aristolochiaceæ). The Virginia serpentaria is nearly erect, the slender, wavy stem sparingly branched near the base, and usually growing to about a foot in height, sometimes, however, even reaching 3 feet. The leaves are thin, ovate, ovate lance shaped or oblong lance shaped, and usually heart shaped at the base; they are about 2½ inches long and about 1 or 1½ inches in width. The flowers are produced from near the base of the plant, similar to its near relative, the Canada snakeroot. They are solitary and terminal, borne on slender, scaly branches, dull brownish purple in color, and of a somewhat leathery texture; the calyx tube is curiously bent or contorted in the shape of the letter S. The fruit is a roundish 6-celled capsule, about half an inch in diameter, and containing numerous seeds. (Pl. III, fig. 3.)

Description of Texas serpentaria.—This species has a very wavy stem, with oval, heart-shaped, clasping leaves, which are rather thick and strongly reticulated or marked with a network of veins; hence the specific name *reticulata*. The entire plant is hairy, with numerous long, coarse hairs. The small, densely hairy purplish flowers are also produced from the base of the plant.

Description of rootstocks.—Serpentaria has a short rootstock with many thin, branching, fibrous roots. (Pl. III, fig. 3.) In the dried state it is thin and bent, the short remains of stems showing on the upper surface and the under surface having numerous thin roots about 4 inches in length, all of a dull yellowish brown color, internally white. It has a very agreeable aromatic odor, somewhat like camphor, and the taste is described as warm, bitterish, and camphoraceous.

The Texas serpentaria has a larger rootstock, with fewer roots less interlaced than the Virginia serpentaria.

Collection, prices, and uses.—The roots of serpentaria are collected in autumn. Various other roots are sometimes mixed with serpentaria, but as they are mostly high-priced drugs, such as goldenseal, pinkroot, senega, and ginseng, their presence in a lot of serpentaria is probably accidental, due simply to proximity

of growth of these plants. Abscess-root (*Polemonium reptans* L.) is another root with which serpentaria is often adulterated. It is very similar to serpentaria, except that it is nearly white. The price of serpentaria ranges from 35 to 40 cents a pound.

Serpentaria is used for its stimulant, tonic, and diaphoretic properties. Both species are official in the United States Pharmacopœia.

YELLOW DOCK.

Rumex crispus L.

Other common names.—Rumex, curled dock, narrow dock, sour dock. (Fig. 5.)

Habitat and range.—This troublesome weed, introduced from Europe, is now found throughout the United States, occurring in cultivated as well as in waste ground, among rubbish heaps, and along roadsides.

FIG. 5.—Yellow dock (*Rumex crispus*), first year's growth.

Description of plant.—Yellow dock is a perennial plant belonging to the buckwheat family (Polygonaceæ), and has a deep, spindle-shaped root, from which arises an erect, angular, and furrowed stem, attaining a height of from 2 to 4 feet. The stem is branched near the top and leafy, bearing numerous long dense clusters formed by drooping groups of inconspicuous green flowers placed in circles around the stem. The flowers are produced from June to August, and the fruits which follow are in the form of small triangular nuts, like the grain of buckwheat, to which family the dock belongs. So long as the fruits are green and immature they can scarcely be distinguished from the flowers, but as they ripen the clusters take on a rusty-brown color. The leaves of the yellow dock are lance shaped, acute, with the margins strongly waved and crisped, the lower long-stalked leaves being blunt or heart shaped at the base and from 6 to 8 inches in length, while those nearer the top are narrower and shorter, only 3 to 6 inches in length, short stemmed or stemless.

The broad-leaved dock (*Rumex obtusifolius* L.), known also as bitter dock, common dock, blunt-leaved dock, and butter-dock, is a very common weed found

in waste places from the New England States to Oregon and south to Florida and Texas. It grows to about the same height as the yellow dock, to which it

FIG. 6.—Broad-leaved dock (*Rumex obtusifolius*), leaf, fruiting spike, and root.

bears a close resemblance, differing principally in its more robust habit of growth. The stem is stouter than in yellow dock, and the leaves, which like-

wise are wavy along the margin, are much broader and longer. The green flowers appear from June to August and are in rather long, open clusters, the groups rather loose and far apart. (Fig. 6.)

Description of roots.—Yellow dock root is large and fleshy, usually from 8 to 12 inches long, tapering or spindle shaped, with few or no rootlets. When dry it is usually twisted and prominently wrinkled, the rather thick, dark, reddish brown bark marked with small scars. The inside of the root is whitish at first, becoming yellowish. The fracture is short, but shows some splintery fibers. The root, as it occurs in commerce, is either entire or occasionally split lengthwise.

The darker colored root of the broad-leaved dock has a number of smaller branches near the crown and more rootlets. (Fig. 6.) Dock roots have but a very faint odor and a bitter, astringent taste.

Collection, prices, and uses.—The roots should be collected in late summer or autumn, after the fruiting tops have turned brown, then washed, either left entire or split lengthwise into halves or quarters, and carefully dried. Yellow dock root ranges from 4 to 6 cents a pound.

In the United States Pharmacopœia of 1890 "the roots of *Rumex crispus* and of some other species of Rumex" were official, and both of the above-named species are used, but the yellow dock (*Rumex crispus*) is the species most commonly employed in medicine. The docks are largely used for purifying the blood and in the treatment of skin diseases.

The young root leaves of both of the species mentioned are sometimes used in spring as pot herbs.

POKEWEED.

Phytolacca decandra L.[a]

Synonym.—*Phytolacca americana* L.[a]

Pharmacopœial name.—Phytolacca.

Other common names.—Poke, pigeon-berry, garget, scoke, pocan, coakum, Virginian poke, inkberry, red inkberry, American nightshade, cancer-jalap, redweed.

Habitat and range.—Pokeweed, a common, familiar, native weed, is found in rich, moist soil along fence rows, fields, and uncultivated land from the New England States to Minnesota south to Florida and Texas.

Description of plant.—In Europe, where pokeweed has become naturalized from this country, it is regarded as an ornamental garden plant, and, indeed, it is very showy and attractive with its reddish purple stems, rich green foliage, and clusters of white flowers and dark-purple berries.

The stout, smooth stems, arising from a very large perennial root, attain a height of from 3 to 9 feet, and are erect and branched, green at first, then reddish. If a piece of the stem is examined, the pith will be seen to be divided into disk-shaped parts with hollow spaces between them. The smooth leaves are borne on short stems and are about 5 inches long and 2 to 3 inches wide, ovate or ovate oblong, acute at the apex, and the margins entire. The long-stalked clusters of whitish flowers, which appear from July to September, are from 3 to 4 inches in length, the flowers numerous and borne on reddish stems. In about two months the berries will have matured and assumed a rich dark-purple color.

[a] *Phytolacca americana* L. by right of priority should be accepted, but *P. decandra* L. is used in conformity with the Pharmacopœia.

These smooth and shining purple berries are globular, flattened at both ends, and contain black seeds embedded in a rich crimson juice. (Fig. 7.) This plant belongs to the pokeweed family (Phytolaccaceæ).

FIG. 7.—Pokeweed (*Phytolacca decandra*), flowering and fruiting branch.

Description of root.—Pokeweed has a very thick, long, fleshy root, conical in shape and branched (fig. 8), very much resembling that of horseradish, and poisonous. In commerce it usually occurs in transverse or lengthwise slices, the outside a yellowish brown and finely wrinkled lengthwise, and thickly encircled with lighter colored ridges. It breaks with a fibrous fracture and is yellowish gray within. The transverse slices show many concentric rings. There is a slight odor and the taste is sweetish and acrid. The root when powdered causes sneezing.

FIG. 8.—Pokeweed root.

Collection, prices, and uses.—The root of the pokeweed, which is official in the United States Pharmacopœia, is collected in the latter part of autumn, thoroughly cleaned, cut into transverse or lengthwise slices, and carefully dried. It brings from 2½ to 4 cents a pound.

The root is used for its alterative properties in treating various diseases of the skin and blood, and in certain cases in relieving pain and allaying inflammation. It also acts upon the bowels and causes vomiting.

The berries when fully matured are also used in medicine.

The young and tender shoots of the pokeweed are eaten in spring, like asparagus, but bad results may follow if they are not thoroughly cooked or if they are cut too close to the root.

SOAPWORT.

Saponaria officinalis L.

Other common names.—Saponaria, saponary, common soapwort, bouncing-bet, soaproot, bruisewort, Boston pink, chimney-pink, crow-soap, hedge-pink, old-maid's-pink, fuller's-herb, lady-by-the-gate, London-pride, latherwort, mock-gilliflower, scourwort, sheepweed, sweet-betty, wild sweet-william, woods-phlox, world's-wonder.

Habitat and range.—By one or another of its many common names this plant, naturalized from Europe, is known almost everywhere, occurring along roadsides and in waste places.

Description of plant.—Soapwort is a rather pretty herbaceous perennial, 1 to 2 feet high, and belonging to the pink family (Silenaceæ). Its smooth, stout, and erect stem is leafy and only sparingly branched, the leaves ovate, 2 to 3 inches long, smooth, prominently ribbed, and pointed at the apex. The bright-looking, crowded clusters of pink (or in shady localities whitish) flowers appear from about June until far along in September. The five petals of the corolla are furnished with long "claws," or, in other words, they are narrowly lengthened toward the base and inserted within the tubular and pale-green calyx. The seed capsule is oblong and one-celled. (Pl. III, fig. 4.)

Description of root.—Soapwort spreads by means of its stolons, or underground runners. But the roots, which are rather long, are the parts employed in medicine. These are cylindrical, tapering toward the apex, more or less branched, and wrinkled lengthwise. (Pl. III, fig. 4.) The whitish wood is covered with a brownish red, rather thick bark, and the root breaks with a short, smooth fracture. It is at first sweetish, bitter, and mucilaginous, followed by a persistently acrid taste, but it has no odor.

Collection, prices, and uses.—As already indicated, the roots, without the runners, should be collected either in spring or autumn. With water they form a lather, like soap, whence the common names soapwort, soaproot, latherwort, etc., are derived. The price ranges from 5 to 10 cents a pound. The roots are employed in medicine for their tonic, alterative, and diaphoretic properties. The leaves are also used.

GOLDENSEAL.

Hydrastis canadensis L.

Pharmacopœial name.—Hydrastis.

Other common names.—Yellowroot, yellow puccoon, orange-root, yellow Indian-paint, turmeric-root, Indian turmeric, Ohio curcuma, ground-raspberry, eye-root, eye-balm, yellow-eye, jaundice-root, Indian-dye.

Habitat and range.—This native forest plant occurs in patches in high, open woods, and usually on hillsides or bluffs affording natural drainage, from southern New York to Minnesota and western Ontario, south to Georgia and Missouri.

Goldenseal is now becoming scarce throughout its range. Ohio, Indiana, Kentucky, and West Virginia have been the greatest goldenseal-producing States.

Description of plant.—Goldenseal is a perennial plant belonging to the same family as the buttercup, namely, the crowfoot family (Ranunculaceæ). It has a thick yellow rootstock, which sends up an erect hairy stem about 1 foot in height, surrounded at the base by 2 or 3 yellowish scales. The yellow color of the roots and scales extends up the stem so far as it is covered by soil, while the portion of the stem above ground has a purplish color. The stem, which

has only two leaves, seems to fork at the top, one branch bearing a large leaf and the other a smaller one and a flower. A third leaf, which is much smaller than the other two and stemless, is occasionally produced. The leaves are palmately 5 to 9 lobed, the lobes broad, acute, sharply and unequally toothed; they are prominently veined on the lower surface, and at flowering time, when they are very much wrinkled, they are only partially developed, but they continue to expand until they are from 6 to 8 inches in diameter, becoming thinner in texture and smoother. The upper leaf subtends or incloses the flower bud.

FIG. 9.—Goldenseal (*Hydrastis canadensis*), flowering plant and fruit.

The greenish white flower appears about April or May, but it is of short duration, lasting only five or six days. It is less than half an inch in diameter and, instead of petals, has three small petal-like sepals, which fall away as soon as the flower expands, leaving only the numerous stamens (as many as 40 or 50), in the center of which are about a dozen pistils, which finally develop into a round, fleshy, berry-like head which ripens in July or August. The fruit when ripe turns a bright red and resembles a large raspberry, whence the common name "ground-raspberry" is derived. It contains from 10 to 20 small, black, shining, hard seeds. (Fig. 9.)

Description of rootstock.—The fresh rootstock of goldenseal, which has a rank, nauseating odor, is bright yellow, both internally and externally, with fibrous yellow rootlets produced from the sides. It is from 1½ to 2½ inches in length, from one-fourth to three-fourths of an inch in thickness, and contains a large amount of yellow juice. (Fig. 10.)

In the dried state the rootstock is crooked, knotty, and wrinkled, from 1 to 2 inches in length, and from one-eighth to one-third of an inch in diameter. It is of a dull-brown color on the outside and breaks with a clean, short, resinous fracture, showing a lemon-yellow color inside. After the rootstock has been kept for some time it will become greenish yellow or brown internally and

its quality impaired. The cup-like depressions or stem scars on the upper surface of the rootstock resemble the imprint of a seal, whence the most popular name of the plant, goldenseal, is derived. The rootstock as found in commerce is almost bare, the fibrous rootlets, which in drying become very wiry and brittle, breaking off readily and leaving only small protuberances.

The odor of the dried rootstock, while not so pronounced as in the fresh material, is peculiar, narcotic, and disagreeable. The taste is exceedingly bitter, and when the rootstock is chewed there is a persistent acridity, which causes an abundant flow of saliva.

Collection, prices, and uses.—The root should be collected in autumn after the seeds have ripened, freed from soil, and carefully dried. After a dry season goldenseal dies down soon after the fruit is mature, so that it often happens that by the end of September not a trace of the plant remains above ground; but if the season has been moist, the plant sometimes persists to the beginning of winter. The price of goldenseal ranges from $1 to $1.50 a pound.

FIG. 10.—Goldenseal rootstock.

Goldenseal, which is official in the United States Pharmacopœia, is a useful drug in digestive disorders and in certain catarrhal affections of the mucous membranes, in the latter instance being administered both internally and locally.

Cultivation.—Once so abundant in certain parts of the country, especially in the Ohio Valley, goldenseal is now becoming scarce throughout its range, and in consequence of the increased demand for the root, both at home and abroad, its cultivation must sooner or later be more generally undertaken in order to satisfy the needs of medicine. In some parts of the country the cultivation of goldenseal is already under way.

The first thing to be considered in growing this plant is to furnish it, as nearly as possible, the conditions to which it has been accustomed in its native forest home. This calls for a well-drained soil, rich in humus, and partially shaded. Goldenseal stands transplanting well, and the easiest way to propagate it is to bring the plants in from the forest and transplant them to a properly prepared location, or to collect the rootstocks and to cut them into as many pieces as there are buds, planting these pieces in a deep, loose, well-prepared soil, and mulching, adding new mulch each year to renew the humus. With such a soil the cultivation of goldenseal is simple, and it will be necessary chiefly to keep down the weeds.

The plants may be grown in rows 1 foot apart and 6 inches apart in the row, or they may be grown in beds 4 to 8 feet wide, with walks between. Artificial shade will be necessary, and this is supplied by the erection of lath sheds. The time required to obtain a marketable crop is from two to three years.

Detailed information regarding the experiments made by the Department will be found in another publication.[a]

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[a] Bulletin 51, Part VI, Bureau of Plant Industry, "Goldenseal."

GOLDTHREAD.

Coptis trifolia (L.) Salisb.

Other common names.—Coptis, cankerroot, mouthroot, yellowroot.

Habitat and range.—This pretty little perennial is native in damp, mossy woods and bogs from Canada and Alaska south to Maryland and Minnesota. It is most common in the New England States, northern New York and Michigan, and in Canada, where it frequents the dark sphagnum swamps, cold bogs, and the shade of dense forests of cedars, pines, and other evergreens.

Description of plant.—Anyone familiar with this attractive little plant will agree that it is well named. The roots of goldthread, running not far beneath the surface of the ground, are indeed like so many tangled threads of gold. The plant in the general appearance of its leaves and flowers very closely resembles the strawberry plant. It is of low growth, only 3 to 6 inches in height, and belongs to the crowfoot family (Ranunculaceæ). The leaves are all basal, and are borne on long, slender stems; they are evergreen, dark green and shining on the upper surface and lighter green beneath, divided into three parts, which are prominently veined and toothed. A single small, white, star-shaped flower is borne at the ends of the flowering stalks, appearing from May to August. (Fig. 11.) The 5 to 7 sepals or lobes of the calyx are white and like petals, and the petals of the corolla, 5 to 7 in number, are smaller, club shaped, and yellow at the base. The seed pods are stalked, oblong, compressed, spreading, tipped with the persistent style, and containing small black seeds.

FIG. 11.—Goldthread (*Coptis trifolia*). After Lloyd's Drugs and Medicines of North America.

Description of root.—Goldthread has a long, slender, creeping root, which is much branched and frequently matted. (Fig. 11.) The color of these roots is a bright golden yellow. As found in the stores, goldthread consists usually of tangled masses of these golden-yellow roots, mixed with the leaves and stems of the plant, but the root is the part prescribed for use. The root is bitter and has no odor.

Collection, prices, and uses.—The time for collecting goldthread is in autumn. After removing the covering of dead leaves and moss, the creeping yellow roots of goldthread will be seen very close to the surface of the ground, from which they can be very easily pulled. They should, of course, be carefully dried. As already stated, although the roots and rootlets are the parts to be used, the commercial article is freely mixed with the leaves and stems of the plant. Evidences of the pine-woods home of this plant, in the form of pine needles and bits of moss, are often seen in the goldthread received for market. Goldthread brings from 60 to 70 cents a pound.

The Indians and early white settlers used this little root as a remedy for various forms of ulcerated and sore mouth, and it is still used as a wash or gargle for affections of this sort. It is also employed as a bitter tonic.

Goldthread was official in the United States Pharmacopœia from 1820 to 1880.

BLACK COHOSH.

Cimicifuga racemosa (L.) Nutt.

Synonym.—*Actæa racemosa* L.

Pharmacopœial name.—Cimicifuga.

Other common names.—Black snakeroot, bugbane, bugwort, rattle-snakeroot, rattleroot, rattleweed, rattletop, richweed, squawroot.

Habitat and range.—Although preferring the shade of rich woods, black cohosh will grow occasionally in sunny situations in fence corners and woodland pastures. It is most abundant in the Ohio Valley, but it occurs from Maine to Wisconsin, south along the Allegheny Mountains to Georgia, and westward to Missouri.

Description of plant.—Rising to a height of 3 to 8 feet, the showy, delicate-flowered spikes of the black cohosh tower above most of the other woodland flowers, making it a conspicuous plant in the woods and one that can be easily recognized.

FIG. 12.—Black cohosh (*Cimicifuga racemosa*), leaves, flowering spikes, and rootstock.

Black cohosh is an indigenous perennial plant belonging to the same family as the goldenseal, namely, the crowfoot family (Ranunculaceæ). The tall stem, sometimes 8 feet in height, is rather slender and leafy, the leaves consisting of three leaflets, which are again divided into threes. The leaflets are about 2 inches long, ovate, sharp pointed at the apex, thin and smooth, variously lobed, and the margins sharply toothed. The graceful, spikelike terminal cluster of flowers, which is produced from June to August, is from 6 inches to 2 feet in length. (Fig. 12.) Attractive as these flower clusters are to the eye, they generally do not prove attractive very long to those who may gather them for their beauty, since the flowers emit an offensive odor, which accounts for some of the common names applied to this plant, namely, bugbane and bugwort, it having been thought that this odor was efficacious in driving away bugs. The flowers do not all open at one time, and thus there may be seen buds, blossoms, and seed pods on one spike. The buds are white and globular, and as

they expand in flower there is practically nothing to the flower but very numerous white stamens and the pistil, but the stamens spread out around the pistil in such a manner as to give to the spike a somewhat feathery or fluffy appearance which is very attractive. The seed pods are dry, thick and leathery, ribbed, and about one-fourth of an inch long, with a small beak at the end. The smooth brown seeds are inclosed within the pods in two rows. Anyone going through the woods in winter may find the seed pods, full of seeds, still clinging to the dry, dead stalk, and the rattling of the seeds in the pods as the wind passes over them has given rise to the common names rattle-snakeroot (not "rattlesnake"-root), rattleweed, rattletop, and rattleroot.

Description of rootstock.—The rootstock (fig. 12) is large, horizontal, and knotty or rough and irregular in appearance. The upper surface of the rootstock is covered with numerous round scars and stumps, the remains of former leaf stems, and on the fresh rootstocks may be seen the young, pinkish white buds which are to furnish the next season's growth. From the lower part of the rootstock long, fleshy roots are produced. The fresh rootstock is very dark reddish brown on the outside, white within, showing a large central pith from which radiate rays of a woody texture, and on breaking the larger roots also the woody rays will be seen in the form of a cross. On drying, the rootstock becomes hard and turns much darker, both internally and externally, but the peculiar cross formation of the woody rays in both rootstock and roots, being lighter in color, is plainly seen without the aid of a magnifying glass. The roots in drying become wiry and brittle and break off very readily. Black cohosh has a heavy odor and a bitter, acrid taste.

Collection, prices, and uses.—The root should be collected after the fruit has ripened, usually in September. The price ranges from 2 to 3 cents a pound.

The Indians had long regarded black cohosh as a valuable medicinal plant, not only for the treatment of snake bites, but it was also a very popular remedy among their women, and it is to-day considered of value as an alterative, emmenagogue, and sedative, and is recognized as official in the United States Pharmacopœia.

OREGON GRAPE.

Berberis aquifolium Pursh.

Pharmacopœial name.—Berberis.

Other common names.—Rocky Mountain grape, holly-leaved barberry, California barberry, trailing Mahonia.

Habitat and range.—This shrub is native in woods in rich soil among rocks from Colorado to the Pacific Ocean, but it is especially abundant in Oregon and northern California.

Description of plant.—Oregon grape is a low-growing shrub, resembling somewhat the familiar Christmas holly of the Eastern States, and, in fact, was first designated as "mountain-holly" by members of the Lewis and Clark expedition on their way through the western country. It belongs to the barberry family (Berberidaceæ), and grows about 2 to 6 feet in height, the branches sometimes trailing. The leaves consist of from 5 to 9 leaflets, borne in pairs, with an odd leaflet at the summit. They are from 2 to 3 inches long and about 1 inch wide, evergreen, thick, leathery, oblong or oblong ovate in outline, smooth and shining above, the margins provided with thorny spines or teeth. The numerous small yellow flowers appear in April or May and are borne in erect, clustered heads. The fruit consists of a cluster of blue or bluish purple berries, having a pleasant taste, and each containing from three to nine seeds. (Pl. IV, fig. 1.)

Other species.—While *Berberis aquifolium* is generally designated as the source of Oregon grape root, other species of Berberis are met with in the market under the name grape root, and their use is sanctioned by the United States Pharmacopœia.

The species most commonly collected with *Berberis aquifolium* is *B. nervosa* Pursh, which is also found in woods from California northward to Oregon and Washington. This is 9 to 16 inches in height, with a conspicuously jointed stem and 11 to 17 bright-green leaflets.

Another species of Berberis, *B. pinnata* Lag., attains a height of from a few inches to 5 feet, with from 5 to 9, but sometimes more, leaflets, which are shining above and paler beneath. This resembles *aquifolium* very closely and is often mistaken for it, but it is said that it has not been used by the medical profession, unless in local practice.[a] The root also is about the same size as that of *aquifolium*, while the root of *nervosa* is smaller.

Some works speak of *Berberis repens* Lindl. as another species often collected with *aquifolium*, but in the latest botanical manuals no such species is recognized, *B. repens* being given simply as a synonym for *B. aquifolium*.

Description of rootstock.—The rootstock and roots of Oregon grape are more or less knotty, in irregular pieces of varying lengths, and about an inch or less in diameter, with brownish bark and hard and tough yellow wood, showing a small pith and narrow rays. Oregon grape root has a very bitter taste and very slight odor.

Collection, prices, and uses.—Oregon grape root is collected in autumn and brings from 10 to 12 cents a pound. The bark should *not* be removed from the rootstocks, as the Pharmacopœia directs that such roots be rejected.

This root has long been used in domestic practice throughout the West as a tonic and blood purifier, and is now official in the United States Pharmacopœia.

The berries are used in making preserves and cooling drinks.

BLUE COHOSH.

Caulophyllum thalictroides (L.) Michx.

Other common names.—Caulophyllum, pappoose-root, squawroot, blueberry-root, blue ginseng, yellow ginseng. (Pl. IV, fig. 2.)

Habitat and range.—Blue cohosh is found in the deep rich loam of shady woods from New Brunswick to South Carolina, westward to Nebraska, being abundant especially throughout the Allegheny Mountain region.

Description of plant.—This member of the barberry family (Berberidaceæ) is a perennial herb, 1 to 3 feet in height, and indigenous to this country. It bears at the top one large, almost stemless leaf, which is triternately compound—that is, the main leaf stem divides into three stems, which again divide into threes, and each division bears three leaflets. Sometimes there is a smaller leaf, but similar to the other, at the base of the flowering branch. The leaflets are thin in texture, oval, oblong, or obovate, and 3 to 5 lobed.

In the early stage of its growth this plant is covered with a sort of bluish green bloom, but it gradually loses this and becomes smooth. The flowers are borne in a small terminal panicle or head, and are small and greenish yellow. They appear from April to May, while the leaf is still small. The globular seeds, which ripen about August, are borne on stout stalks in membranous capsules and resemble dark-blue berries.

[a] King's American Dispensatory, Vol. I, 1898, from Berberidaceæ, by C. G. and J. U. Lloyd, 1878.

Description of rootstock.—The thick crooked rootstock of blue cohosh is almost concealed by the mass of matted roots which surrounds it. There are numerous cup-shaped scars and small branches on the upper surface of the rootstock, while the lower surface gives off numerous long, crooked, matted roots. Some of the scars are depressed below the surface of the rootstock, while others are raised above it. The outside is brownish and the inside tough and woody. Blue cohosh possesses a slight odor and a sweetish, somewhat bitter and acrid taste. In the powdered state it causes sneezing.

Collection, prices, and uses.—The root is dug in the fall. Very often the roots of goldenseal or twinleaf are found mixed with those of blue cohosh. The price of blue cohosh root ranges from 2½ to 4 cents a pound.

Blue cohosh, official in the United States Pharmacopœia for 1890, is used as a demulcent, antispasmodic, emmenagogue, and diuretic.

FIG. 13.—Twinleaf (*Jeffersonia diphylla*), plant and seed capsule. (After Britton and Brown, Illustrated Flora.)

TWINLEAF.

Jeffersonia diphylla (L.) Pers.

Other common names.—Jeffersonia, rheumatism-root, helmetpod, ground-squirrel pea, yellowroot.

Habitat and range.—Twinleaf inhabits rich shady woods from New York to Virginia and westward to Wisconsin.

Description of plant.—This native herbaceous perennial is only about 6 to 8 inches in height when in flower. At the fruiting stage it is frequently 18 inches in height. It is one of our early spring plants, and its white flower, resembling that of bloodroot, is produced as early as April.

The long-stemmed, smooth leaves, produced in pairs and arising from the base of the plant, are rather oddly formed. They are about 3 to 6 inches long, 2 to 4 inches wide, heart shaped or kidney shaped, but parted lengthwise into two lobes or divisions, really giving the appearance of two leaves; hence the common name "twinleaf." The flower with its eight oblong, spreading white petals measures about 1 inch across, and is borne at the summit of a slender stalk arising from the root. The many-seeded capsule is about 1 inch long, leathery, somewhat pear shaped, and opening halfway around near the top, the upper part forming a sort of lid. (Fig. 13.) Twinleaf belongs to the barberry family (Berberidaceæ).

Description of rootstock.—Twinleaf has a horizontal rootstock, with many fibrous, much-matted roots, and is very similar to that of blue cohosh, but not so long. It is thick, knotty, yellowish brown externally, with a resinous bark, and internally yellowish. The inner portion is nearly tasteless, but the bark has a bitter and acrid taste.

Collection, prices, and uses.—The rootstock is collected in autumn, and is used as a diuretic, alterative, antispasmodic, and a stimulating diaphoretic. Large

doses are said to be emetic and smaller doses tonic and expectorant. The price paid for twinleaf root ranges from about 5 to 7 cents a pound.

MAY-APPLE.

Podophyllum peltatum L.

Pharmacopœial name.—Podophyllum.

Other common names.—Mandrake, wild mandrake, American mandrake, wild lemon, ground-lemon, hog-apple, devil's-apple, Indian apple, raccoon-berry, duck's-foot, umbrella-plant, vegetable calomel.

Habitat and range.—The May-apple is an indigenous plant, found in low woods, usually growing in patches, from western Quebec to Minnesota, south to Florida and Texas.

Description of plant.—A patch of May-apple can be distinguished from afar, the smooth, dark-green foliage and close and even stand making it a conspicuous feature of the woodland vegetation.

May-apple is a perennial plant, and belongs to the barberry family (Berberidaceæ). It is erect, and grows about 1 foot in height. The leaves are only two in number, circular in outline, but with five to seven deep lobes, the lobes 2 cleft, and toothed at the apex; they are dark green above, the lower surface lighter green and somewhat hairy or smooth, sometimes 1 foot in diameter, and borne on long leafstalks which are fixed to the center of the leaf, giving it an umbrella-like appearance. The waxy-white, solitary flower, sometimes 2 inches in diameter, appears in May, nodding on its short stout stalk, generally right between the two large umbrella-like leaves, which shade it and hide it from view. (Fig. 14.) The fruit which follows is lemon shaped, at first green, then yellow, about 2 inches in length, and edible, although when eaten immoderately it is known to have produced bad effects.

FIG. 14.—May-apple (*Podophyllum peltatum*), upper portion of plant with flower, and rootstock.

In a patch of May-apple plants there are always a number of sterile or flowerless stalks, which bear leaves similar to those of the flowering plants.

Description of rootstock.—The horizontally creeping rootstock of May-apple (fig. 14), when taken from the ground, is from 1 to 6 feet or more in length, flexible, smooth, and round, dark brown on the outside and whitish and

fleshy within; at intervals of a few inches are thickened joints, on the upper surface of which are round stem scars and on the lower side a tuft of rather stout roots. Sometimes the rootstock bears lateral branches. The dried rootstock, as it occurs in the stores, is in irregular, somewhat cylindrical pieces, smooth or somewhat wrinkled, yellowish brown or dark brown externally, whitish to pale brown internally, breaking with a short, sharp fracture, the surface of which is mealy. The odor is slight and the taste at first sweetish, becoming very bitter and acrid.

Collection, prices, and uses.—The proper time for collecting the rootstock is in the latter half of September or in October. The price paid for May-apple root ranges from 3 to 6 cents a pound.

May-apple root, which is recognized as official in the United States Pharmacopœia, is an active cathartic, and was known as such to the Indians.

CANADA MOONSEED.

Menispermum canadense L.

Other common names.—Menispermum, yellow parilla, Texas sarsaparilla, yellow sarsaparilla, vine-maple. (Pl. IV, fig. 3.)

Habitat and range.—Canada moonseed is usually found along streams in woods, climbing over bushes, its range extending from Canada to Georgia and Arkansas.

Description of plant.—This native perennial woody climber reaches a length of from 6 to 12 feet, the round, rather slender stem bearing very broad, slender-stalked leaves. These leaves are from 4 to 8 inches wide, smooth and green on the upper surface and paler beneath, roundish in outline and entire, or sometimes lobed and resembling the leaves of some of our maples, whence the common name "vine-maple" is probably derived. The bases of the leaves are generally heart shaped and the apex pointed or blunt. In July the loose clusters of small yellowish or greenish white flowers are produced, followed in September by bunches of black one-seeded fruit, covered with a "bloom" and very much resembling grapes. Canada moonseed belongs to the moonseed family (Menispermaceæ).

Description of rootstock.—The rootstock and roots are employed in medicine. In the stores it will be found in long, straight pieces, sometimes 3 feet in length, only about one-fourth of an inch in thickness, yellowish brown or grayish brown, finely wrinkled lengthwise, and giving off fine, hairlike, branched, brownish roots from joints which occur every inch or so. The inside shows a distinct white pith of variable thickness and a yellowish white wood with broad, porous wood rays, the whole breaking with a tough, woody fracture. It has practically no odor, but a bitter taste.

Collection, prices, and uses.—Canada moonseed is collected in autumn, and brings from 4 to 8 cents a pound. It is used as a tonic, alterative, and diuretic, and was official in the United States Pharmacopœia for 1890.

BLOODROOT.

Sanguinaria canadensis L.

Pharmacopœial name.—Sanguinaria.

Other common names.—Redroot, red puccoon, red Indian-paint, puccoon-root, coonroot, white puccoon, panson, snakebite, sweet-slumber, tetterwort, turmeric.

Habitat and range.—Bloodroot is found in rich, open woods from Canada south to Florida and west to Arkansas and Nebraska.

Description of plant.—This indigenous plant is among the earliest of our spring flowers, the waxy-white blossom, enfolded by the grayish green leaf, usually making its appearance early in April. The stem and root contain a blood-red juice. Bloodroot is a perennial, and belongs to the same family as the opium poppy, the Papaveraceæ. Each bud on the thick, horizontal rootstock produces but a single leaf and a flowering scape, reaching about 6 inches in height (fig. 15). The plant is smooth, and both stem and leaves, especially when young, present a grayish green appearance, being covered with a "bloom" such as is found on some fruits. The leaves are palmately 5 to 9 lobed, the lobes either cleft at the apex or having a wavy margin, and are borne on leaf stems about 6 to 14 inches long. After the plants have ceased flowering the leaves, at first only 3 inches long and 4 to 5 inches broad, continue to expand until they are about 4 to 7 inches long and 6 to 12 inches broad. The under side of the leaf is paler than the upper side and shows prominent veins. The flower measures about 1 inch across, is white, rather waxlike in appearance, with numerous golden-yellow stamens in the center. The petals soon fall off, and the oblong, narrow seed pod develops, attaining a length of about an inch.

FIG. 15.—Bloodroot (*Sanguinaria canadensis*), flowering plant with rootstock.

Description of rootstock.—When dug out of the ground bloodroot is rather thick, round, and fleshy, slightly curved at the ends, and contains a quantity of blood-red juice. It is from 1 to 4 inches in length, from ½ to 1 inch in thickness, externally reddish brown, internally a bright-red blood color, and produces many thick, orange-colored rootlets. (Fig. 15.)

The rootstock shrinks considerably in drying, the outside turning dark brown and the inside orange-red or yellowish with numerous small red dots, and it breaks with a short, sharp fracture. It has but a slight odor, and the taste is bitter and acrid and very persistent. The powdered root causes sneezing.

Collection, prices, and uses.—The rootstock should be collected in autumn, after the leaves have died, and after curing it should be stored in a dry place, as it rapidly deteriorates if allowed to become moist. Age also impairs its activity. The price paid to collectors for this root ranges from about 5 to 10 cents a pound.

Bloodroot was well known to the American Indians, who used the red juice as a dye for skins and baskets and for painting their faces and bodies. It is official in the United States Pharmacopœia, and is used as a tonic, alterative, stimulant, and emetic.

HYDRANGEA.

Hydrangea arborescens L.

Other common names.—Wild hydrangea, seven-barks.

Habitat and range.—Hydrangea frequents rocky river banks and ravines from the southern part of New York to Florida, and westward to Iowa and Missouri, being especially abundant in the valley of the Delaware and southward.

Description of plant.—Hydrangea is an indigenous shrub, 5 to 6 feet or more in height, with weak twigs, slender leaf stems and thin leaves. It belongs to the hydrangea family (Hydrangeaceæ). The leaves are oval or sometimes heart

shaped, 3 to 6 inches long, sharply toothed, green on both sides, the upper smooth and the lower sometimes hairy. The shrub is in flower from June to July, producing loose, branching, terminal heads of small, greenish white flowers, followed by membranous, usually 2-celled capsules, which contain numerous seeds. (Pl. IV, fig. 4.) Sometimes hydrangea will flower a second time, early in fall.

A peculiar characteristic of this shrub, and one that has given rise to the common name "seven-barks," is the peeling off of the stem bark, which comes off in several successive layers of thin, different colored bark.

Description of root.—The root is roughly branched and when first taken from the ground is very juicy, but after drying it becomes hard. The smooth white and tough wood is covered with a thin, pale-yellow or light-brown bark, which readily scales off. The wood is tasteless, but the bark has a pleasant aromatic taste, becoming somewhat pungent.

Collection, prices, and uses.—Hydrangea root is collected in autumn, and as it becomes very tough after drying and difficult to bruise it is best to cut the root in short transverse pieces while it is fresh and still juicy and dry it in this way. The price ranges from 2 to 7 cents a pound.

Hydrangea has diuretic properties and is said to have been much used by the Cherokees and early settlers in calculous complaints.

INDIAN-PHYSIC.

Porteranthus trifoliatus (L.) Britton.

Synonym.—*Gillenia trifoliata* Moench.

Other common names.—Gillenia, bowman's-root, false ipecac, western dropwort, Indian-hippo.

Habitat and range.—Indian-physic is native in rich woods from New York to Michigan, south to Georgia and Missouri.

Description of plant.—The reddish stems of this slender, graceful perennial of the rose family (Rosaceæ) are about 2 to 3 feet high, several erect and branched stems being produced from the same root. The leaves are almost stemless and trifoliate; that is, composed of three leaflets. They are ovate or lanceolate, 2 to 3 inches long, narrowed at the base, smooth, and toothed. The nodding, white or pinkish flowers are few, produced in loose terminal clusters from May to July. (Pl. V, fig. 1.) The five petals are long, narrowed or tapering toward the base, white or pinkish, and inserted in the tubular, somewhat bell-shaped, red-tinged calyx. The seed pods are slightly hairy.

At the base of the leaf stems are small leaflike parts, called stipules, which in this species are very small, linear, and entire. In the following species, which is very similar to *trifoliatus* and collected with it, the stipules, however, are so much larger that they form a prominent character, which has given rise to its specific name, *stipulatus*.

Porteranthus stipulatus (Muhl.) Britton (Syn. *Gillenia stipulacea* Nutt.) is found in similar situations as *P. trifoliatus*, but generally farther west, its range extending from western New York to Indiana and Kansas, south to Alabama, Louisiana, and Indian Territory. The general appearance of this plant is very similar to that of *P. trifoliatus*. It grows to about the same height, but is generally more hairy, the leaflets narrower and more deeply toothed, and the flowers perhaps a trifle smaller. The stipules, however, will generally serve to distinguish it. These are large, broad, ovate, acute at the apex, sharply and deeply notched, and so much like leaves that but for their position at the base of the leaf stems they might easily be mistaken for them.

With the exception of the name American ipecac applied to this plant, the common names of *Porteranthus trifoliatus* are also used for *P. stipulatus*. The roots of both species are collected and used for the same purposes.

Description of roots.—The root of *Porteranthus trifoliatus* is thick and knotty, with many smoothish, reddish brown rootlets (Pl. V, fig. 1), the latter in drying becoming wrinkled lengthwise and showing a few transverse fissures or breaks in the bark, and the interior white and woody. There is practically no odor, and the woody portion is tasteless, but the bark, which is readily separable, is bitter, increasing the flow of saliva.

Porteranthus stipulatus has a larger, more knotty root, with rootlets that are more wavy, constricted, or marked with numerous transverse rings, and the bark fissured or breaking from the white woody portion at frequent intervals.

Collection, prices, and uses.—The roots of both species are collected in autumn. The price ranges from 2 to 4 cents a pound.

Indian-physic or bowman's root, as these names imply, was a popular remedy with the Indians, who used it as an emetic. From them the white settlers learned of its properties, and it is still used for its emetic action. This drug was at one time official in the United States Pharmacopœia, from 1820 to 1880. Its action is said to resemble that of ipecac.

FIG. 16.—Wild indigo (*Baptisia tinctoria*), branch showing flowers and seed pods. (Modified from Barton's Vegetable Materia Medica.)

WILD INDIGO.

Baptisia tinctoria (L.) R. Br.

Other common names.—Baptisia, indigo-weed, yellow indigo, American indigo, yellow broom, indigo-broom, clover-broom, broom-clover, horsefly-weed, shoofly, rattlebush.

Habitat and range.—This native herb grows on dry, poor land, and is found from Maine to Minnesota, south to Florida and Louisiana.

Description of plant.—Many who have been brought up in the country will recognize in the wild indigo the plant so frequently used by farmers, especially in Virginia and Maryland, to keep flies away from horses, bunches of it being fastened to the harness for this purpose.

Wild indigo grows about 2 to 3 feet in height, and the cloverlike blossoms and leaves will show at once that it belongs to the same family as the common

clover, namely, the pea family (Fabaceae). It is an erect, much-branched, very leafy plant, of compact growth, the 3-leaved, bluish green foliage somewhat resembling clover leaves. The flowers, as already stated, are like common clover flowers—that is, not like clover heads, but the single flowers composing these; they are bright yellow, about one-half inch in length, and are produced in numerous clusters which appear from June to September. The seed pods, on stalks longer than the calyx, are nearly globular or ovoid and are tipped with an awl-shaped style. (Fig. 16.)

Another species, said to possess properties similar to those of *Baptisia tinctoria*, and substituted for it, is *B. alba* R. Br., called the white wild indigo. This plant has white flowers and is found in the Southern States and on the plains of the Western States.

Description of root.—Wild indigo has a thick, knotty crown or head, with several stem scars, and a round, fleshy root, sending out cylindrical branches and rootlets almost 2 feet in length. The white woody interior is covered with a thick, dark-brown bark, rather scaly or dotted with small, wartlike excrescences. The root breaks with a tough, fibrous fracture. There is a scarcely perceptible odor, and the taste, which resides chiefly in the bark, is nauseous, bitter, and acrid.

Collection, prices, and uses.—The root of wild indigo is collected in autumn, and brings from 4 to 8 cents a pound.

Large doses of wild indigo are emetic and cathartic and may prove dangerous. It also has stimulant, astringent, and antiseptic properties, and is used as a local application to sores, ulcers, etc.

The herb is sometimes employed like the root, and the entire plant was official from 1830 to 1840.

In some sections the young tender shoots are used for greens, like those of the pokeweed, but great care must be exercised to gather them before they are too far advanced in growth, as otherwise bad results will follow.

A blue coloring matter has been prepared from the plant and used as a substitute for indigo, to which, however, it is very much inferior.

CRANE'S-BILL.

Geranium maculatum L.

Pharmacopœial name.—Geranium.

Other common names.—Spotted crane's-bill, wild crane's-bill, stork's-bill, spotted geranium, wild geranium, alumroot, alumbloom, chocolate-flower, crowfoot, dovefoot, old-maid's-nightcap, shameface.

Habitat and range.—Crane's-bill flourishes in low grounds and open woods from Newfoundland to Manitoba, south to Georgia and Missouri.

Description of plant.—This pretty perennial plant belongs to the geranium family (Geraniaceæ), and will grow sometimes to a height of 2 feet, but more generally it is only about a foot in height. The entire plant is more or less covered with hairs, and is erect and usually unbranched. The leaves are nearly circular or somewhat heart shaped in outline, 3 to 6 inches wide, deeply parted into three or five parts, each division again cleft and toothed. The basal leaves are borne on long stems, while those above have shorter stems. The flowers, which appear from April to June, are borne in a loose cluster; they are rose purple, pale or violet purple in color, about 1 inch or 1½ inches wide, the petals delicately veined and woolly at the base, and the sepals or calyx lobes with a bristle-shaped point, soft-hairy, the margins having a fringe of more bristly hairs. The fruit consists of a beaked capsule, springing open elastically, and dividing into five cells, each cell containing one seed. (Fig. 17.)

Description of rootstock.—When removed from the earth, the rootstock of crane's-bill (fig. 17) is about 2 to 4 inches long, thick, with numerous branches bearing the young buds for next season's growth, and scars showing the remains of stems of previous years, brown outside, white and fleshy internally, and with several stout roots. When dry, the rootstock turns a darker brown, is finely wrinkled externally, and has a rough, spiny appearance, caused by the shrinking of the buds and branches and the numerous stem scars with which the root is studded. Internally it is of a somewhat purplish color. Crane's-bill root is without odor and the taste is very astringent.

FIG. 17.—Crane's-bill (*Geranium maculatum*), flowering plant, showing also seed pods and rootstock.

Collection, prices, and uses.—Crane's-bill root depends for its medicinal value on its astringent properties, and as its astringency is due to the tannin content, the root should, of course, be collected at that season of the year when it is richest in that constituent. Experiments have proved that the yield of tannin in crane's-bill is greatest just before flowering, which is in April or May, according to locality. It should, therefore, be collected just before the flowering period, and not, as is commonly the case, in autumn. The price of this root ranges from 4 to 8 cents a pound.

Crane's-bill root, which is official in the United States Pharmacopœia, is used as a tonic and astringent.

SENECA SNAKEROOT.

Polygala senega L.

Pharmacopœial name.—Senega.

Other common names.—Senega snakeroot, Seneca-root, rattlesnake-root, mountain-flax.

Habitat and range.—Rocky woods and hillsides are the favorite haunts of this indigenous plant. It is found in such situations from New Brunswick and western New England to Minnesota and the Canadian Rocky Mountains, and south along the Allegheny Mountains to North Carolina and Missouri.

Description of plant.—The perennial root of this useful little plant sends up a number of smooth, slender, erect stems (as many as 15 to 20 or more),

sometimes slightly tinged with red, from 6 inches to a foot in height, and generally unbranched. The leaves alternate on the stem, are lance shaped or oblong lance shaped, thin in texture, 1 to 2 inches long, and stemless. The flowering spikes are borne on the ends of the stems and consist of rather crowded, small, greenish white, insignificant flowers. The flowering period of Seneca snakeroot is from May to June. The spike blossoms gradually, and when the lowermost flowers have already fruited the upper part of the spike is still in flower. The seed capsules are small and contain two black, somewhat hairy seeds. (Fig. 18.) The short slender stalks supporting these seed capsules have a tendency to break off from the main axis before the seed is fully mature, leaving the spike in a rather ragged-looking condition, and the yield of seed, therefore, is not very large. Seneca snakeroot belongs to the milkwort family (Polygalaceæ).

FIG. 18.—Seneca snakeroot (*Polygala senega*), flowering plant with root.

A form of Seneca snakeroot, growing mostly in the North-Central States and distinguished by its taller stems and broader leaves, has been called *Polygala sĕnega* var. *latifolia*.

Description of root.—Seneca snakeroot (fig. 18) is described in the United States Pharmacopœia as follows: "Somewhat cylindrical, tapering, more or less flexuous, 3 to 15 cm. long and 2 to 8 mm. thick, bearing several similar horizontal branches and a few rootlets; crown knotty with numerous buds and short stem remnants; externally yellowish gray or brownish yellow, longitudinally wrinkled, usually marked by a keel which is more prominent in perfectly dry roots near the crown; fracture short, wood light yellow, usually excentrically developed; odor slight, nauseating; taste sweetish, afterwards acrid."

The Seneca snakeroots found in commerce vary greatly in size, that obtained from the South, which is really the official drug, being usually light colored and small. The principal supply of Seneca snakeroot now comes from Minnesota, Wisconsin, and farther northward, and this western Seneca snakeroot has a much larger, darker root, with a crown or head sometimes measuring 2 or 3 inches across and the upper part of the root very thick. It is also less twisted and not so distinctly keeled.

Seneca snakeroot is often much adulterated with the roots of other species of Polygala and of other plants.

Collection, prices, and uses.—The time for collecting Seneca snakeroot is in autumn. Labor conditions play a great part in the rise and fall of prices for this drug. It is said that very little Seneca snakeroot has been dug in the Northwest during 1906, due to the fact that the Indians and others who usually engage in this work were so much in demand as farm hands and railroad laborers, which paid them far better than the digging of Seneca snakeroot. Collectors receive from about 55 to 70 cents a pound for this root.

This drug, first brought into prominence as a cure for snake bite among the Indians, is now employed as an expectorant, emetic, and diuretic. It is official in the Pharmacopœia of the United States.

STILLINGIA.

Stillingia sylvatica L.

Pharmacopœial name.—Stillingia.

Other common names.—Queen's-delight, queen's-root, silverleaf, nettle-potato.

Habitat and range.—This plant is found in dry, sandy soil and in pine barrens from Maryland to Florida west to Kansas and Texas.

Description of plant.—Like most of the other members of the spurge family (Euphorbiaceæ) stillingia also contains a milky juice. This indigenous, herbaceous perennial is about 1 to 3 feet in height, bright green and somewhat fleshy, with crowded leaves of a somewhat leathery texture. The leaves are practically stemless and vary greatly in form, from lance shaped, oblong, to oval and elliptical, round toothed or saw toothed. The pale-yellow flowers, which appear from April to October, are borne in a dense terminal spike and consist of two kinds, male and female, the male flowers arranged in dense clusters around the upper part of the stalk and the female flowers occurring at the base of the spike. (Fig. 19.) The seeds are contained in a roundish 3-lobed capsule.

FIG. 19.—Stillingia (*Stillingia sylvatica*), upper portion of plant and part of spike showing male flowers. (After Bentley and Trimen, Medicinal Plants.)

Description of root.—Stillingia consists of somewhat cylindrical or slenderly spindle-shaped roots from 6 inches to a foot in length, slightly branched, the yellowish white, porous wood covered with a rather thick, reddish brown, wrinkled bark, the whole breaking with a fibrous fracture. As found in commerce, stillingia is usually in short transverse sections, the ends of the sections

pinkish and fuzzy with numerous fine, silky bast fibers, and the bark showing scattered yellowish brown resin cells and milk ducts. It has a peculiar unpleasant odor, and a bitter, acrid, and pungent taste.

Collection, prices, and uses.—Stillingia root is collected late in autumn or early in spring, usually cut into short, transverse sections and dried. The price ranges from 3 to 5 cents a pound.

This root, which is official in the United States Pharmacopœia, has been a popular drug in the South for more than a century, and is employed principally as an alterative.

WILD SARSAPARILLA.

Aralia nudicaulis L.

Other common names.—False sarsaparilla, Virginian sarsaparilla, American sarsaparilla, small spikenard, rabbit's-root, shotbush, wild licorice.

Habitat and range.—Wild sarsaparilla grows in rich, moist woods from Newfoundland west to Manitoba and south to North Carolina and Missouri.

Description of plant.—This native herbaceous perennial, belonging to the ginseng family (Araliaceæ), produces a single, long-stalked leaf and flowering stalk from a very short stem, both surrounded or sheathed at the base by thin, dry scales. The leafstalk is about 12 inches long, divided at the top into three parts, each division bearing five oval, toothed leaflets from 2 to 5 inches long, the veins on the lower surface sometimes hairy.

The naked flowering stalk bears three spreading clusters of small, greenish flowers, each cluster consisting of from 12 to 30 flowers, produced from May to June, followed later in the season by purplish black roundish berries, about the size of the common elderberries. (Pl. V, fig. 2.)

Description of rootstock.—Wild sarsaparilla rootstock has a very fragrant, aromatic odor. Rabbits are said to be very fond of it, whence one of the common names, "rabbit's-root," is derived. The rootstock is rather long, horizontally creeping, somewhat twisted, and yellowish brown on the outside. (Pl. V, fig. 2.) The taste is warm and aromatic. The dried rootstock is brownish gray and wrinkled lengthwise on the outside, about one-fourth of an inch in thickness, the inside whitish with a spongy pith. The taste is sweetish and somewhat aromatic.

Collection, prices, and uses.—The root of wild sarsaparilla is collected in autumn, and brings from 5 to 8 cents a pound.

This has long been a popular remedy, both among the Indians and in domestic practice, and was official in the United States Pharmacopœia from 1820 to 1880. Its use is that of an alterative, stimulant, and diaphoretic, and in this it resembles the official sarsaparilla obtained from tropical America.

Similar species.—The American spikenard (*Aralia racemosa* L.), known also as spignet, spiceberry, Indian-root, petty-morrel, life-of-man, and old-man's-root, is employed like *Aralia nudicaulis*. It is distinguished from this by its taller, herbaceous habit, its much-branched stem from 3 to 6 feet high, and very large leaves consisting of thin, oval, heart-shaped, double saw-toothed leaflets. The small greenish flowers are arranged in numerous clusters, instead of only three as in *nudicaulis*, and also appear somewhat later, namely, from July to August. The berries are roundish, reddish brown, or dark purple.

The rootstock is shorter than that of *nudicaulis*, and much thicker, with prominent stem scars, and furnished with numerous, very long, rather thick roots. The odor and taste are stronger than in *nudicaulis*. It is also collected in autumn, and brings from 4 to 8 cents a pound.

The American spikenard occurs in similar situations as *nudicaulis*, but its range extends somewhat farther south, Georgia being given as the southern limit.

The California spikenard (*Aralia californica* Wats.) may be used for the same purposes as the other species. The plant is larger than *Aralia racemosa*, but otherwise is very much like it. The root is also larger than that of *A. racemosa*.

GINSENG.

Panax quinquefolium L.

Other common names.—American ginseng, sang, red-berry, five-fingers. (Pl. V, fig. 3.)

Habitat and range.—Ginseng is a native of this country, its favorite haunts being the rich, moist soil in hardwood forests from Maine to Minnesota southward to the mountains of northern Georgia and Arkansas. For some years ginseng has been cultivated in small areas from central New York to Missouri.

Description of plant.—Ginseng is an erect perennial plant growing from 8 to 15 inches in height, and bearing three leaves at the summit, each leaf consisting of five thin, stalked, ovate leaflets, long pointed at the apex, rounded or narrowed at the base, the margins toothed; the three upper leaflets are largest and the two lower ones smaller. From 6 to 20 greenish yellow flowers are produced in a cluster during July and August, followed later in the season by bright crimson berries. It belongs to the ginseng family (Araliaceæ).

Description of root.—Ginseng has a thick, spindle-shaped root, 2 to 3 inches long or more, and about one-half to 1 inch in thickness, often branched, the outside prominently marked with circles or wrinkles. (Pl. V, fig. 3.) The spindle-shaped root is simple at first, but after the second year it usually becomes forked or branched, and it is the branched root, especially if it resembles the human form, that finds particular favor in the eyes of the Chinese, who are the principal consumers of this root.

Ginseng root has a thick, pale yellowish white or brownish yellow bark, prominently marked with transverse wrinkles, the whole root fleshy and somewhat flexible. If properly dried, it is solid and firm. Ginseng has a slight aromatic odor, and the taste is sweetish and mucilaginous.

Collection and uses.—The proper time for digging ginseng root is in autumn, and it should be carefully washed, sorted, and dried. If collected at any other season of the year, it will shrink more and not have the fine plump appearance of the fall-dug root.

The National Dispensatory contains an interesting item concerning the collection of the root by the Indians. They gather the root only after the fruit has ripened, and it is said that they bend down the stem of ripened fruit before digging the root, covering the fruit with earth, and thus providing for future propagation. The Indians claim that a large percentage of the seeds treated in this way will germinate.

Although once official in the United States Pharmacopœia, from 1840 to 1880, it is but little used medicinally in this country except by the Chinese residents, most of the ginseng produced in this country being exported to China. The Chinese regard ginseng root as a panacea. It is on account of its commercial prominence that it is included in this paper.

Cultivation.—There is probably no plant that has become better known, at least by name, during the past ten years or more than ginseng. It has been heralded from north to south and east to west as a money-making crop. The

prospective ginseng grower must not fail to bear in mind, however, that financial returns are by no means immediate. Special conditions and unusual care are required in ginseng cultivation, diseases must be contended with, and a long period of waiting is in store for him before he can realize on his crop.

Either roots or seeds may be planted, and the best success with ginseng is obtained by following as closely as possible the conditions of its native habitat. Ginseng needs a deep, rich soil, and, being a plant accustomed to the shade of forest trees, will require shade, which can be supplied by the erection of lath sheds over the beds. A heavy mulch of leaves or similar well-rotted vegetable material should be applied to the beds in autumn.

If roots are planted, they are set in rows about 8 inches apart and 8 inches apart in the row. In this way a marketable product will be obtained sooner than if grown from seed. The seed is sown in spring or autumn in drills 6 inches apart and about 2 inches apart in the row. The plants remain in the seed bed for two years and are then transplanted, being set about 8 by 8 inches apart. It requires from five to seven years to obtain a marketable crop from the seed. Seed intended for sowing should not be allowed to dry out, as this is supposed to destroy its vitality.

Price.—The price of wild ginseng roots ranges from $5 a pound upward. The cultivated root generally brings a lower price than the wild root, and southern ginseng roots are worth less than those from northern localities.

Exports.—The exports of ginseng for the year ended June 30, 1906, amounted to 160,949 pounds, valued at $1,175,844.

WATER-ERYNGO.

Eryngium yuccifolium Michx.

Synonym.—Eryngium aquaticum L.

Other common names.—Eryngium, eryngo, button-snakeroot, corn-snakeroot, rattlesnake-master, rattlesnake-weed, rattlesnake-flag.

Habitat and range.—Although sometimes occurring on dry land, water-eryngo usually inhabits swamps and low, wet ground, from the pine barrens of New Jersey westward to Minnesota and south to Texas and Florida.

Description of plant.—The leaves of this plant are grasslike in form, rigid, 1 to 2 feet long, and about one-half inch or a trifle more in width; they are linear, with parallel veins, pointed, generally clasping at the base, and the margins bristly with soft, slender spines. The stout, furrowed stem reaches a height of from 2 to 6 feet, and is generally unbranched except near the top. The insignificant whitish flowers are borne in dense, ovate-globular, stout-stemmed heads, appearing from June to September, and the seed heads that follow are ovate and scaly. (Pl. V, fig. 4.) Water-eryngo belongs to the parsley family (Apiaceæ) and is native in this country.

Description of rootstock.—The stout rootstock is very knotty, with numerous short branches, and produces many thick, rather straight roots (Pl. V, fig. 4), both rootstock and roots of a dark-brown color, the latter wrinkled lengthwise. The inside of the rootstock is yellowish white. Water-eryngo has a somewhat peculiar, slightly aromatic odor, and a sweetish, mucilaginous taste at first, followed by some bitterness and pungency.

Collection, prices, and uses.—The root of this plant is collected in autumn and brings from 5 to 10 cents a pound.

Water-eryngo is an old remedy, and one of its early uses, as the several common names indicate, was for the treatment of snake bites. It was official in the United States Pharmacopœia from 1820 to 1860, and is employed now as a

diuretic and expectorant, and for promoting perspiration. In large doses it acts as an emetic, and the root, when chewed, excites a flow of saliva. It is said to resemble Seneca snakeroot in action.

AMERICAN ANGELICA.

Angelica atropurpurea L.

Synonym.—*Archangelica atropurpurea* Hoffm.

Other common names.—Angelica, purple-stemmed angelica, great angelica, high angelica, purple angelica, masterwort.

Habitat and range.—American angelica is a native herb, common in swamps and damp places from Labrador to Delaware and west to Minnesota.

Description of plant.—This strong-scented, tall, stout perennial reaches a height of from 4 to 6 feet, with a smooth, dark-purple, hollow stem 1 to 2 inches in diameter. The leaves are divided into three parts, each of which is again divided into threes; the rather thin segments are oval or ovate, somewhat acute, sharply toothed and sometimes deeply cut, and about 2 inches long. The lower leaves sometimes measure 2 feet in width, while the upper ones are smaller, but all have very broad expanded stalks. The greenish white flowers are produced from June to July in somewhat roundish, many-rayed umbels or heads, which sometimes are 8 to 10 inches in diameter. The fruits are smooth, compressed, and broadly oval. (Pl. VI, fig. 1.) American angelica belongs to the parsley family (Apiaceæ).

Description of root.—American angelica root is branched, from 3 to 6 inches long, and less than an inch in diameter. The outside is light brownish gray, with deep furrows, and the inside nearly white, the whole breaking with a short fracture and the thick bark showing fine resin dots. It has an aromatic odor, and the taste at first is sweetish and spicy, afterwards bitter. The fresh root is said to possess poisonous properties.

The root of the European or garden angelica (*Angelica officinalis* Moench) supplies much of the angelica root of commerce. This is native in northern Europe and is very widely cultivated, especially in Germany, for the root.

Collection, prices, and uses.—The root is dug in autumn and carefully dried. Care is also necessary in preserving the root, as it is very liable to the attacks of insects. American angelica root ranges from 6 to 10 cents a pound.

American angelica root, which was official in the United States Pharmacopœia from 1820 to 1860, is used as an aromatic, tonic, stimulant, carminative, diuretic, and diaphoretic. In large doses it acts as an emetic.

The seeds are also employed medicinally.

YELLOW JASMINE OR JESSAMINE.

Gelsemium sempervirens (L.) Ait. f.

Pharmacopœial name.—Gelsemium.

Other common names.—Carolina jasmine or jessamine, Carolina wild woodbine, evening trumpet-flower.

Habitat and range.—Yellow jasmine is a plant native to the South, found along banks of streams, in woods, lowlands, and thickets, generally near the coast, from the eastern part of Virginia to Florida and Texas, south to Mexico and Guatemala.

Description of plant.—This highly ornamental climbing or trailing plant is abundantly met with in the woods of the Southern States, its slender stems festooned over trees and fences and making its presence known by the delight-

ful perfume exhaled by its flowers, filling the air with a fragrance that is almost overpowering wherever the yellow jasmine is very abundant.

The smooth, shining stems of this beautiful vine sometimes reach a length of 20 feet. The leaves are evergreen, lance shaped, entire, 1½ to 3 inches long, rather narrow, borne on short stems, and generally remaining on the vine during the winter. The flowers, which appear from January to April, are bright yellow, about 1 to 1½ inches long, the corolla funnel shaped. (Fig. 20.) They are very fragrant, but poisonous, and it is stated that the eating of honey derived from jasmine flowers has brought about fatal results.

Yellow jasmine is a perennial, and belongs to a family that is noted for its poisonous properties, namely, the Logania family (Loganiaceæ), which numbers among its members such powerful poisonous agents as the strychnine-producing tree.

FIG. 20.—Yellow jasmine (*Gelsemium sempervirens*).

Description of rootstock.—The rootstock of the yellow jasmine is horizontal and runs near the surface of the ground, attaining great length, 15 feet or more; it is branched, and here and there produces fibrous rootlets. When freshly removed from the ground it is very yellow, with a peculiar odor and bitter taste. For the drug trade it is generally cut into pieces varying from 1 inch to 6 inches in length, and when dried consists of cylindrical sections about 1 inch in thickness, the roots, of course, thinner. The bark is thin, yellowish brown, with fine silky bast fibers, and the wood is tough and pale yellow, breaking with a splintery fracture and showing numerous fine rays radiating from a small central pith. Yellow jasmine has a bitter taste and a pronounced heavy odor.

Collection, prices, and uses.—The root of yellow jasmine is usually collected just after the plant has come into flower and is cut into pieces from 1 to 6 inches long. It is often adulterated with portions of the stems, but these can be distinguished by their thinness and dark purplish color. The prices range from 3 to 5 cents a pound.

Yellow jasmine, which is official in the United States Pharmacopœia, is used for its powerful effect on the nervous system.

PINKROOT.

Spigelia marilandica L.

Pharmacopœial name.—Spigelia.

Other common names.—Carolina pinkroot, Carolina pink, Maryland pink, Indian pink, starbloom, wormgrass, wormweed, American wormroot.

Habitat and range.—This pretty little plant is found in rich woods from New Jersey to Florida, west to Texas and Wisconsin, but occurring principally in the Southern States. It is fast disappearing, however, from its native haunts.

Description of plant.—Pinkroot belongs to the same family as the yellow jasmine, namely, the Logania family (Loganiaceæ), noted for its poisonous species. It is a native perennial herb, with simple, erect stem 6 inches to 1½ feet high, nearly smooth. The leaves are stemless, generally ovate, pointed at the apex and rounded or narrowed at the base; they are from 2 to 4 inches long, one-half to 2 inches wide, smooth on the upper surface, and only slightly hairy on the veins on the lower surface. The rather showy flowers are produced from May to July in a terminal one-sided spike; they are from 1 to 2 inches in length, somewhat tube shaped, narrowed below, slightly inflated toward the center, and again narrowed or contracted toward the top, and terminating in five lance-shaped lobes; the flowers are very showy, with their brilliant coloring—bright scarlet on the outside, and the inside of the tube and the lobes a bright yellow. The seed capsule is double, consisting of two globular portions more or less united, and containing numerous seeds. (Pl. VI, fig. 2.)

Description of rootstock.—The rootstock is rather small, from 1 to 2 inches in length and about one-sixteenth of an inch in thickness. It is somewhat crooked or bent, dark brown, with a roughened appearance of the upper surface caused by cup-shaped scars, the remains of former annual stems. The lower surface and the sides have numerous long, finely branched, lighter colored roots, which are rather brittle. Pinkroot has a pleasant, aromatic odor, and the taste is described as sweetish, bitter, and pungent.

Collection, prices, and uses.—Pinkroot is collected after the flowering period. It is said to be scarce, and was reported as becoming scarce as long ago as 1830. The price paid to collectors ranges from 25 to 40 cents a pound.

The roots of other plants, notably those of the East Tennessee pinkroot (*Ruellia ciliosa* Pursh), are often found mixed with the true pinkroot, and the *Ruellia ciliosa* is even substituted for it. This adulteration or substitution probably accounts for the inertness which has sometimes been attributed to the true pinkroot and which has caused it to fall into more or less disuse. It has long been known that the true pinkroot was adulterated, but this adulteration was supposed to be caused by the admixture of Carolina phlox (*Phlox carolina* L., now known as *Phlox ovata* L.), but this is said now to be no part of the substitution.[a]

The rootstock of *Ruellia ciliosa* is larger and not as dark as that of the Maryland pinkroot and has fewer and coarser roots, from which the bark readily separates, leaving the whitish wood exposed.

Pinkroot was long known by the Indians, and its properties were made known to physicians by them. It is official in the United States Pharmacopœia, and is used principally as an anthelmintic.

AMERICAN COLOMBO.

Frasera carolinensis Walt.

Synonym.—*Frasera walteri* Michx.

Other common names.—Frasera, meadowpride, pyramid-flower, pyramid-plant, Indian-lettuce, yellow gentian, ground-centaury.

[a] Bulletin 100, Part V, Bureau of Plant Industry, "The Drug Known as Pinkroot."

Habitat and range.—American colombo occurs in dry soil from the western part of New York to Wisconsin, south to Georgia and Kentucky.

Description of plant.—During the first and second year of the growth of this plant only the root leaves are produced. These are generally somewhat rounded at the summit, narrowed toward the base, and larger than the stem leaves, which develop in the third year. The leaves are deep green and produced mostly in whorls of four, the stem leaves being 3 to 6 inches in length and oblong or lance shaped. In the third year the stem is developed and the flowers are produced from June to August. The stem is stout, erect, cylindrical, and 3 to 8 feet in height. The flowers of American colombo are borne in large terminal, handsome pyramidal clusters sometimes 2 feet in length, and are greenish yellow or yellowish white, dotted with brown purple. They are slender stemmed, about 1 inch across, with a wheel-shaped, 4-parted corolla. The seeds are contained in a much compressed capsule. (Fig. 21.) American colombo is an indigenous perennial, and belongs to the gentian family (Gentianaceæ).

FIG. 21.—American colombo (*Frasera carolinensis*), leaves, flowers, and seed pods.

Description of root.—The root is long, horizontal, spindle shaped, yellow, and wrinkled. In the fresh state it is fleshy and quite heavy. The American colombo root of commerce, formerly in transverse slices, now generally occurs in lengthwise slices. The outside is yellowish or pale orange and the inside spongy and pale yellow. The taste is bitter. American colombo root resembles the official gentian root in taste and odor, and the uses are also similar.

Collection, prices, and uses.—The proper time for collecting American colombo root is in the autumn of the second year or in March or April of the third year. It is generally cut into lengthwise slices before drying. The price of American colombo root ranges from 3 to 5 cents a pound.

The dried root, which was official in the United States Pharmacopœia from 1820 to 1880, is used as a simple tonic. In the fresh state the root possesses emetic and cathartic properties.

BLACK INDIAN HEMP.

Apocynum cannabinum L.

Pharmacopœial name.—Apocynum.

Other common names.—Canadian hemp, American hemp, amy-root, bowman's-root, bitterroot, Indian-physic, rheumatism-weed, milkweed, wild cotton, Choctaw-root.

The name "Indian hemp" is often applied to this plant, but it should never be used without the adjective "black." "Indian hemp" is a name that properly belongs to *Cannabis indica*, a true hemp plant, from which the narcotic drug "hashish" is obtained.

Habitat and range.—Black Indian hemp is a native of this country, and may be found in thickets and along the borders of old fields throughout the United States.

Description of plant.—This is a common herbaceous perennial about 2 to 4 feet high, with erect or ascending branches, and, like most of the plants belonging to the dogbane family (Apocynaceæ), contains a milky juice. The short-stemmed opposite leaves are oblong, lance-shaped oblong or ovate-oblong, about 2 to 6 inches long, usually sharp pointed, the upper surface smooth and the lower sometimes hairy. The plant is in flower from June to August and the small greenish white flowers are borne in dense heads, followed later by the slender pods, which are about 4 inches in length and pointed at the apex. (Fig. 22.)

FIG. 22.—Black Indian hemp (*Apocynum cannabinum*), flowering portion, pods, and rootstock (After King's American Dispensatory.)

Other species.—Considerable confusion seems to exist in regard to which species yields the root which has proved of greatest value medicinally. The Pharmacopœia directs that "the dried rhizome and roots of *Apocynum cannabinum* or of closely allied species of Apocynum" be used.

In the older botanical works and medical herbals only two species of Apocynum were recognized, namely, *A. cannabinum* L. and *A. androsæmifolium* L., although it was known that both of these were very variable. In the newer botanical manuals both of these species still hold good, but the different forms and variations are now recognized as distinct species, those formerly referred to *cannabinum* being distinguished by the erect or nearly erect lobes of the corolla, and those of the *androsæmifolium* group being distinguished by the spreading or recurved lobes of the corolla.

Among the plants that were formerly collected as *Apocynum cannabinum* or varietal forms of it, and which are now considered as distinct species, may be mentioned the following:

Riverbank-dogbane (*A. album* Greene), which frequents the banks of rivers and similar moist locations from Maine to Wisconsin, Virginia, and Missouri.

This plant is perfectly smooth and has white flowers and relatively smaller leaves than *A. cannabinum*.

Velvet dogbane (*A. pubescens* R. Br.), which is common from Virginia to Illinois, Iowa, and Missouri. The entire plant has a soft, hairy or velvety appearance, which renders identification easy. According to the latest edition of the National Standard Dispensatory it is not unlikely that this is the plant that furnishes the drug that has been so favorably reported upon.

Apocynum androsaemifolium is also gathered by drug collectors for *Apocynum cannabinum*. Its root is likewise employed in medicine, but its action is not the same as that of *cannabinum*, and it should therefore not be substituted for it. It closely resembles *cannabinum*.

Description of rootstock.—The following description of the drug as found in commerce is taken from the United States Pharmacopœia: "Of varying length, 3 to 8 mm. thick, cylindrical or with a few angles produced by drying, lightly wrinkled longitudinally, and usually more or less fissured transversely; orange-brown, becoming gray-brown on keeping; brittle; fracture sharply transverse, exhibiting a thin brown layer of cork, the remainder of the bark nearly as thick as the radius of the wood, white or sometimes pinkish, starchy, containing laticiferous ducts; the wood yellowish, having several rings, finely radiate and very coarsely porous; almost inodorous, the taste starchy, afterwards becoming bitter and somewhat acrid."

Collection, prices, and uses.—The root of black Indian hemp is collected in autumn and brings from 8 to 10 cents a pound.

It is official in the United States Pharmacopœia and has emetic, cathartic, diaphoretic, expectorant, and diuretic properties, and on account of the last-named action it is used in dropsical affections.

The tough fibrous bark of the stalks of black Indian hemp was employed by the Indians as a substitute for hemp in making twine, fishing nets, etc.

PLEURISY-ROOT.

Asclepias tuberosa L.

Pharmacopœial name.—Asclepias.

Other common names.—Butterfly-weed, Canada-root, Indian-posy, orange-root, orange swallowwort, tuberroot, whiteroot, windroot, yellow or orange milkweed.

Habitat and range.—Pleurisy-root flourishes in the open or in pine woods, in dry sandy or gravelly soil, usually along the banks of streams. Its range extends from Ontario and Maine to Minnesota, south to Florida, Texas, and Arizona, but it is found in greatest abundance in the South.

Description of plant.—This is a very showy and ornamental perennial plant, indigenous to this country, and belonging to the milkweed family (Asclepiadaceæ); it is erect and rather stiff in habit, but with brilliant heads of bright orange-colored flowers that attract attention from afar.

The stems are rather stout, erect, hairy, about 1 to 2 feet in height, sometimes branched near the top, and bearing a thick growth of leaves. These are either stemless or borne on short stems, are somewhat rough to the touch, 2 to 6 inches long, lance shaped or oblong, the apex either sharp pointed or blunt, with a narrow, rounded, or heart-shaped base. The flower heads, borne at the ends of the stem and branches, consist of numerous, oddly shaped orange-colored flowers. The corolla is composed of five segments, which are reflexed or turned back, and the crown has five erect or spreading "hoods," within each of which is a slender incurved horn. The plant is in flower for some

time, usually from June to September, followed late in fall by pods, which are from 4 to 5 inches long, green, tinged with red, finely hairy on the outside, and containing the seeds with their long silky hairs. (Pl. VI, fig. 3.) Unlike the other milkweeds, the pleurisy-root contains little or no milky juice.

Description of root.—The root of this plant is large, white and fleshy, spindle shaped, branching. (Pl. VI, fig. 3.) As found in commerce it consists of lengthwise or crosswise pieces from 1 to 6 inches in length and about three-fourths of an inch in thickness. It is wrinkled lengthwise and also transversely and has a knotty head. The thin bark is orange brown and the wood yellowish, with white rays. It has no odor, and a somewhat bitter, acrid taste.

Collection, prices, and uses.—The root, which is usually found rather deep in the soil, is collected in autumn, cut into transverse or lengthwise slices, and dried. The price ranges from 6 to 10 cents a pound.

Pleurisy-root was much esteemed by the Indians, has long been used in domestic practice, and is official in the United States Pharmacopœia. It is used in disordered digestion and in affections of the lungs, in the last-named instance to promote expectoration, relieve pains in the chest, and induce easier breathing. It is also useful in producing perspiration.

Other species.—Besides the official pleurisy-root there are two other species of Asclepias which are employed to some extent for the same purposes, namely, the common milkweed and the swamp-milkweed.

The common milkweed (*Asclepias syriaca* L.) is a perennial, native in fields and waste places from Canada to North Carolina and Kansas. It has a stout, usually simple stem 3 to 5 feet in height and oblong or oval leaves, smooth on the upper surface and densely hairy beneath. The flowers, similar in form to those of *Asclepias tuberosa*, are pinkish purple and appear from June to August, followed by erect pods 3 to 5 inches long, wooly with matted hairs and covered with prickles and borne on recurved stems. The plant contains an abundance of milky juice.

The root of the common milkweed is from 1 to 6 feet long, cylindrical, and finely wrinkled. The short branches and scars left by former stems give the root a rough, knotty appearance. The bark is thick, grayish brown, and the inside white, the root breaking with a short, splintery fracture. Common milkweed root has a very bitter taste, but no odor.

It is collected in autumn and cut into transverse slices before drying. Common milkweed root ranges from 6 to 8 cents a pound.

Swamp-milkweed (*Asclepias incarnata* L.) is a native perennial herb found in swamps from Canada to Tennessee and Kansas. The slender stem, leafy to the top, is 1 to 2 feet in height, branched above, the leaves lance shaped or oblong lance shaped. The flowers, also similar to those of *tuberosa*, appear from July to September, and are flesh colored or rose colored. The pods are 2 to 3½ inches long, erect, and very sparingly hairy.

The root of the swamp-milkweed, which is also collected in autumn, is not quite an inch in length, hard and knotty, with several light-brown rootlets. The tough white wood, which has a thick central pith, is covered with a thin, yellowish brown bark. It is practically without odor, and the taste, sweetish at first, finally becomes bitter. This root brings about 3 cents a pound.

COMFREY.

Symphytum officinale L.

Other common names.—Symphytum, healing-herb, knitback, ass-ear, backwort, blackwort, bruisewort, gum-plant, slippery-root.

Habitat and range.—Comfrey is naturalized from Europe, and occurs in waste places from Newfoundland to Minnesota, south to Maryland.

Description of plant.—This coarse, rough, hairy perennial herb is from 2 to 3 feet high, erect and branched, with thick, rough leaves, the lower ones ovate lance shaped, 3 to 10 inches long, pointed at the apex, and narrowed at the base into margined stems. The uppermost leaves are lance shaped, smaller, and stemless. Comfrey is in flower from June to August, the purplish or dirty-white, tubular, bell-shaped flowers numerous and borne in dense terminal clusters. (Pl. VI, fig. 4.) The nutlets which follow are brown, shining, and somewhat wrinkled. Comfrey belongs to the borage family (Boraginaceæ).

Description of root.—Comfrey has a large, deep, spindle-shaped root, thick and fleshy at the top, white inside, and covered with a thin, blackish brown bark. (Pl. VI, fig. 4.) The dried root is hard, black, and very deeply and roughly wrinkled, breaking with a smooth, white, waxy fracture. As it occurs in commerce it is in pieces ranging from about an inch to several inches in length, only about one-fourth of an inch in thickness, and usually considerably bent. It has a very mucilaginous, somewhat sweetish and astringent taste, but no odor.

Collection, prices, and uses.—The root is dug in autumn, or sometimes in early spring. Comfrey root when first dug is very fleshy and juicy, but about four-fifths of its weight is lost in drying. The price ranges from 4 to 8 cents a pound.

The mucilaginous character of comfrey root renders it useful in coughs and diarrheal complaints. Its action is demulcent and slightly astringent.

The leaves are also used to some extent.

STONEROOT.

Collinsonia canadensis L.

Other common names.—Collinsonia, knobroot, knobgrass, knobweed, knotroot, horse-balm, horseweed, richweed, richleaf, ox-balm, citronella.

Habitat and range.—Stoneroot is found in moist, shady woods from Maine to Wisconsin, south to Florida and Kansas.

Description of plant.—Like most of the other members of the mint family (Menthaceæ), stoneroot is aromatic also, the fresh flowering plant possessing a very pleasant, lemon-like odor. It is a tall, perennial herb, growing as high as 5 feet. The stem is stout, erect, branched, smooth, or the upper part hairy.

The leaves are opposite, about 3 to 8 inches long, thin, ovate, pointed at the apex, narrowed or sometimes heart shaped at the base, and coarsely toothed; the lower leaves are largest and are borne on slender stems, while the upper ones are smaller and almost stemless. Stoneroot is in flower from July to October, producing large, loose, open terminal panicles or heads of small, pale-yellow lemon-scented flowers. The flowers have a funnel-shaped 2-lipped corolla, the lower lip larger, pendent, and fringed, with two very much protruding stamens. (Pl. VII, fig. 1.)

Description of root.—Even the fresh root of this plant is very hard. It is horizontal, large, thick, and woody, and the upper side is rough and knotty and branched irregularly. (Pl. VII, fig. 1.) The odor of the root is rather disagreeable, and the taste pungent and spicy. In the fresh state, as well as when dry, the root is extremely hard, whence the common name "stoneroot." The dried root is grayish brown externally, irregularly knotty on the upper surface from the remains of branches and the scars left by former stems, and the lower surface showing a few thin roots. The inside of the root is hard and whitish.

Collection, prices, and uses.—Stoneroot, which is collected in autumn, is employed for its tonic, astringent, diuretic, and diaphoretic effects. The price of the root ranges from 2 to 3½ cents a pound.

The leaves are used by country people as an application to bruises.

CULVER'S-ROOT.

Veronica virginica L.[a]

Synonym.—*Leptandra virginica* (L.) Nutt.[a]

Pharmacopœial name.—Leptandra.

Other common names.—Culver's-physic, blackroot, bowman's-root, Beaumont-root, Brinton-root, tall speedwell, tall veronica, physic-root, whorlywort.

Habitat and range.—This common indigenous herb is found abundantly in moist, rich woods, mountain valleys, meadows, and thickets from British Columbia south to Alabama, Missouri, and Nebraska.

Description of plant.—Culver's-root is a tall, slender-stemmed perennial belonging to the figwort family (Scrophulariaceæ). It is from 3 to 7 feet in height, with the leaves arranged around the simple stems in whorls of three to nine. The leaves are borne on very short stems, are lance shaped, long pointed at the apex, narrowed at the base, and sharply toothed, 3 to 6 inches in length, and 1 inch or less in width. The white tube-shaped flowers, with two long protruding stamens, are produced from June to September and are borne in several terminal, densely crowded, slender, spikelike heads from 3 to 9 inches long. (Fig. 23.)

FIG. 23.—Culver's-root (*Veronica virginica*), flowering top and rootstock.

[a] Some authors hold that this plant belongs to the genus Leptandra and that its name should be *Leptandra virginica* (L.) Nutt. The Pharmacopœia is here followed.

The flowers, as stated, are usually white, though the color may vary from a pink to bluish or purple, and on account of its graceful spikes of pretty flowers it is often cultivated in gardens as an ornamental plant. The fruits are small, oblong, compressed, many-seeded capsules.

Description of rootstock.—After they are dried the rootstocks have a grayish brown appearance on the outside, and the inside is hard and yellowish, either with a hollow center or a brownish or purplish pith. When broken the fracture is tough and woody. The rootstock measures from 4 to 6 inches in length, is rather thick and bent, with branches resembling the main rootstock. The upper surface has a few stem scars, and from the sides and underneath numerous coarse, brittle roots are produced, which have the appearance of having been artificially inserted into the rootstock. (Fig. 23.) Culver's-root has a bitter and acrid taste, but no odor.

Collection, prices, and uses.—The rootstock and roots should be collected in the fall of the second year. When fresh these have a faint odor, resembling somewhat that of almonds, which is lost in drying. The bitter, acrid taste of Culver's-root also becomes less the longer it is kept, and it is said that it should be kept at least a year before being used. The price paid to collectors ranges from 6 to 10 cents a pound.

Culver's-root, which is official in the United States Pharmacopœia, is used as an alterative, cathartic, and in disorders of the liver.

DANDELION.

Taraxacum officinale Weber.[a]

Synonyms.—*Taraxacum taraxacum* (L.) Karst.;[a] *Taraxacum dens-leonis* Desf.

Pharmacopœial name.—Taraxacum.

Other common names.—Blow-ball, cankerwort, doon-head-clock, fortune-teller, horse gowan, Irish daisy, yellow gowan, one-o'clock. (Fig. 24.)

Habitat and range.—With the exception, possibly, of a few localities in the South, the dandelion is at home almost everywhere in the United States, being a familiar weed in meadows and waste places, and especially in lawns. It has been naturalized in this country from Europe and is distributed as a weed in all civilized parts of the world.

Description of plant.—It is hardly necessary to give a description of the dandelion, as almost everyone is familiar with the coarsely toothed, smooth, shining green leaves, the golden-yellow flowers which open in the morning and only in fair weather, and the round, fluffy seed heads of this only too plentiful weed of the lawns. In spring the young, tender leaves are much sought after by the colored market women about Washington, who collect them by the basketful and sell them for greens or salad.

Dandelion is a perennial belonging to the chicory family (Cichoriaceæ), and is in flower practically throughout the year. The entire plant contains a white milky juice.

Description of root.—The dandelion has a large, thick, and fleshy taproot, sometimes measuring 20 inches in length. In commerce, dandelion root is usually found in pieces 3 to 6 inches long, dark brown on the outside and strongly wrinkled lengthwise. It breaks with a short fracture and shows the thick

[a] Although the combination *Taraxacum taraxacum* (L.) Karst. should be accepted by right of priority, the usage of the Pharmacopœia is followed.

whitish bark marked with circles of milk ducts and a thin woody center, which is yellow and porous. It is practically without odor and has a bitter taste.

Collection and uses.—Late in summer and in fall the milky juice becomes thicker and the bitterness increases, and this is the time to collect dandelion root. It should be carefully washed and thoroughly dried. Dandelion roots lose considerably in drying, weighing less than half as much as the fresh roots. The dried root should not be kept too long, as drying diminishes its medicinal activity. It is official in the United States Pharmacopœia.

Dandelion is used as a tonic in diseases of the liver and in dyspepsia.

FIG. 21.—Dandelion (*Taraxacum officinale*).

Imports and prices.—Most of the dandelion root found on the market is collected in central Europe. There has been an unusually large demand for dandelion root during the season of 1907, and according to the weekly records contained in the "Oil, Paint, and Drug Reporter," the imports entered at the port of New York from January 1, 1907, to the end of May amounted to about 47,000 pounds. The price ranges from 4 to 10 cents a pound.

QUEEN-OF-THE-MEADOW.

Eupatorium purpureum L.

Other common names.—Gravelroot, Indian gravelroot, joe-pye-weed, purple boneset, tall boneset, kidneyroot, king-of-the-meadow, marsh-milkweed, motherwort, niggerweed, quillwort, slunkweed, trumpetweed.

Habitat and range.—This common native perennial herb occurs in low grounds and dry woods and meadows from Canada to Florida and Texas.

Description of plant.—The stout, erect, green or purple stem of this plant grows from 3 to 10 feet in height, and is usually smooth, simple or branched at the top. The thin, veiny leaves are 4 to 12 inches long, 1 to 3 inches wide, ovate or ovate lance shaped, sharp pointed, toothed, and placed around the stem in whorls of three to six. While the upper surface of the leaves is smooth, there is usually a slight hairiness along the veins on the lower surface, otherwise smooth. Toward the latter part of the summer and in early fall queen-of-the-meadow is in flower, producing 5 to 15 flowered pink or purplish heads, all aggregated in large compound clusters, which present a rather showy appearance. (Pl. VII, fig. 2.) This plant belongs to the aster family (Asteraceæ).

Another species which is collected with this and for similar purposes, and by some regarded as only a variety, is the spotted boneset or spotted joe-pye-weed (*Eupatorium maculatum* L.). This is very similar to *E. purpureum*, but it does not grow so tall, is rough-hairy, and has the stem spotted with purple. The thicker leaves are coarsely toothed and in whorls of three to five, and the flower clusters are flattened at the top rather than elongated as in *E. purpureum*. It is found in moist soil from New York to Kentucky, westward to Kansas, New Mexico, Minnesota, and as far up as British Columbia.

Description of root.—Queen-of-the-meadow root, as it occurs in commerce, is blackish and woody, furnished with numerous long dark-brown fibers, which are furrowed or wrinkled lengthwise and whitish within. It has a bitter, aromatic, and astringent taste.

Collection, prices, and uses.—The root is collected in autumn and is used for its astringent and diuretic properties. It was official in the United States Pharmacopœia from 1820 to 1840. The price ranges from 2½ to 4 cents a pound.

ELECAMPANE.

Inula helenium L.

Other common names.—Inula, inul, horseheal, elf-dock, elfwort, horse-elder, scabwort, yellow starwort, velvet dock, wild sunflower.

Habitat and range.—This perennial herb has been naturalized from Europe, and is found along roadsides and in fields and damp pastures from Nova Scotia to North Carolina, westward to Missouri and Minnesota. It is native also in Asia.

Description of plant.—When in flower elecampane resembles the sunflower on a small scale. Like the sunflower, it is a member of the aster family (Asteraceæ). It is a rough plant, growing from 3 to 6 feet in height, but producing during the first year only root leaves, which attain considerable size. In the following season the stout densely hairy stem develops, attaining a height of from 3 to 6 feet.

The leaves are broadly oblong in form, toothed, the upper surface rough and the under side densely soft-hairy. The basal or root leaves are borne on long stems, and are from 10 to 20 inches long and 4 to 8 inches wide, while the upper leaves are smaller and stemless or clasping.

About July to September the terminal flower heads are produced, either singly or a few together. As already stated, these flower heads look very much like small sunflowers, 2 to 4 inches broad, and consist of long, narrow, yellow rays, 3 toothed at the apex, and the disk also is yellow. (Pl. VII, fig. 3.)

Description of root.—Elecampane has a large, long, branching root, pale yellow on the outside and whitish and fleshy within. (Pl. VII, fig. 3.) When dry the outside turns a grayish brown or dark brown, and is generally finely wrinkled lengthwise. As found in commerce, elecampane is usually in transverse or lengthwise slices, light yellow or grayish and fleshy internally, dotted with numerous shining resin cells, and with overlapping brown and wrinkled bark. These slices become flexible in damp weather, and tough, but when they are dry they break with a short fracture. The root has at first a strongly aromatic odor, which has been described by some as resembling a violet odor, but this diminishes in drying. The taste is aromatic, bitterish, and pungent.

Collection, prices, and uses.—The best time for collecting elecampane is in the fall of the second year. If collected later than that the roots are apt to

be stringy and woody. Owing to the interlacing habit of the rootlets, much dirt adheres to the root, but it should be well cleaned, cut into transverse or lengthwise slices, and carefully dried in the shade. Collectors receive from 3 to 5 cents a pound for this root.

Elecampane, which was official in the United States Pharmacopœia of 1890, is much used in affections of the respiratory organs, in digestive and liver disorders, catarrhal discharges, and in skin diseases.

ECHINACEA.

Brauneria angustifolia (DC.) Heller.

Synonym.—*Echinacea angustifolia* DC.

Other common names.—Pale-purple coneflower, Sampson-root, niggerhead (in Kansas).

Habitat and range.—Echinacea is found in scattered patches in rich prairie soil or sandy soil from Alabama to Texas and northwestward, being most abundant in Kansas and Nebraska. Though not growing wild in the Eastern States, it has succeeded well under cultivation in the testing gardens of the Department of Agriculture at Washington, D. C.

Description of plant.—This native herbaceous perennial, belonging to the aster family (Asteraceæ), grows to a height of from 2 to 3 feet. It sends up a rather stout bristly-hairy stem, bearing thick rough-hairy leaves, which are broadly lance shaped or linear lance shaped, entire, 3 to 8 inches long, narrowed at each end, and strongly three nerved. The lower leaves have slender stems, but as they approach the top of the plant the stems become shorter and some of the upper leaves are stemless.

The flower heads, appearing from July to October, are very pretty, and the plant would do well as an ornamental in gardens. The flowers remain on the plant for a long time, and the color varies from whitish rose to pale purple. The heads consist of ray flowers and disk flowers, the former constituting the "petals" surrounding the disk, and the disk itself being composed of small, tubular, greenish yellow flowers. When the flowers first appear the disk is flattened or really concave, but as the flowering progresses it becomes conical in shape. The brown fruiting heads are conical, chaffy, stiff, and wiry. (Pl. VII, fig. 4.)

Description of root.—Echinacea has a thick, blackish root (Pl. VII, fig. 4), which in commerce occurs in cylindrical pieces of varying length and thickness. The dried root is grayish brown on the outside, the bark wrinkled lengthwise and sometimes spirally twisted. It breaks with a short, weak fracture, showing yellow or greenish yellow wood wedges, which give the impression that the wood is decayed.

The odor is scarcely perceptible, and the taste is mildly aromatic, afterwards becoming acrid and inducing a flow of saliva.

Collection, prices, and uses.—The root of echinacea is collected in autumn and brings from 20 to 30 cents a pound. It is said that echinacea varies greatly in quality, due chiefly to the locality in which it grows. According to J. U. Lloyd, the best quality comes from the prairie lands of Nebraska, and that from marshy places is inferior.

Echinacea is said to be an alterative, and to promote perspiration and induce a flow of saliva. The Indians used the freshly scraped roots for the cure of snake bites.

BURDOCK.

Arctium lappa L.

Synonym.—*Lappa major* Gaertn.

Pharmacopœial name.—Lappa.

Other common names.—Cockle-button, cuckold-dock, beggar's-buttons, hurr-bur, stick-button, hardock, bardane. (Fig. 25.)

Habitat and range.—Burdock, one of our most common weeds, was introduced from the Old World. It grows along roadsides, in fields, pastures, and waste places, being very abundant in the Eastern and Central States and in some scattered localities in the West.

FIG. 25.—Burdock (*Arctium lappa*), flowering branch and root.

Description of plant.—Farmers are only too well acquainted with this coarse, unsightly weed. During the first year of its growth this plant, which is a biennial belonging to the aster family (Asteraceæ), produces only a rosette of large, thin leaves from a long tapering root. In the second year a round, fleshy, and branched stem is produced, the plant when full grown measuring from 3 to 7 feet in height. This stem is branched, grooved, and hairy, bearing very large leaves, the lower ones often measuring 18 inches in length. The leaves are placed alternately on the stem, on long, solid, deeply furrowed leafstalks; they are thin in texture, smooth on the upper surface, pale and woolly underneath: usually heart shaped, but sometimes roundish or oval, with even, wavy, or toothed margins.

The flowers are not produced until the second year, appearing from July until frost. Burdock flowers are purple, in small, clustered heads armed with hooked tips, and the spiny burs thus formed are a great pest, attaching themselves to clothing and to the wool and hair of animals. Burdock is a very prolific seed producer, one plant bearing as many as 400,000 seeds.

Description of root.—Burdock has a large, fleshy taproot (fig. 25), which, when dry, becomes scaly and wrinkled lengthwise and has a blackish brown or grayish brown color on the outside, hard, breaking with a short, somewhat fleshy fracture, and showing the yellowish wood with a whitish spongy center. Sometimes there is a small, white, silky tuft at the top of the root, which is formed by the remains of the bases of the leafstalks. The odor of the root is weak and unpleasant, the taste mucilaginous, sweetish, and somewhat bitter.

While the root is met with in commerce in its entire state, it is more frequently in broken pieces or in lengthwise slices, the edges of which are turned inward. The roots of other species of Arctium are also employed.

Collection, prices, and uses.—Burdock root is official, and the United States Pharmacopœia directs that it be collected from plants of the first year's growth, either of *Arctium lappa* or of other species of Arctium. As burdock has a rather large, fleshy root, it is difficult to dry and is apt to become moldy, and for this reason it is better to slice the root lengthwise, which will facilitate the drying process. The price ranges from 5 to 10 cents a pound. The best root is said to come from Belgium, where great care is exercised in its collection and curing.

Burdock root is used as an alterative in blood and skin diseases. The seeds and fresh leaves are also used medicinally to a limited extent.

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PLATES.

EXPLANATION OF PLATES.

PLATE I. Fig. 1.—Marginal-fruited shield-fern (*Dryopteris marginalis*), showing upper surface of leaf, the lower surface with the "sori," or "fruit dots," arranged on the margins, and the erect, chaffy rootstock. Fig. 2.—Skunk-cabbage (*Spathyema foetida*), showing flowering plant with thick rootstock and whorl of crowded roots; unfolded leaf and spathe laid open to show rounded spadix; also seedling, and transverse section of rootstock. Fig. 3.—Sweet-flag (*Acorus calamus*), showing swordlike leaves, flowering head produced from the side of the stalk, and long, creeping rootstock. Fig. 4.—Bethroot (*Trillium erectum*), showing leaves, various views of the flower, and root. Arrangement of the different parts of the plant is in threes.

PLATE II. Fig. 1.—Chamaelirium (*Chamaelirium luteum*), showing the male plant. Note the arrangement of the long-stemmed leaves along the entire stem and the graceful spike of feathery flowers, as compared with the grasslike basal leaves and the erect flowering spikes of Aletris (fig. 2), with which it is often confused. The rootstock of Chamaelirium, with the slightly curved upward end, is also shown. Fig. 2.—Aletris (*Aletris farinosa*). Note the grasslike leaves at the base of the stem and the erect spikes of urn-shaped flowers, as compared with the arrangement of the leaves all along the stem and the drooping plumelike spikes of Chamaelirium (fig. 1), with which Aletris is frequently confused. The rootstock of Aletris, which is rough and scaly and almost completely hidden by the fibrous roots, is, unfortunately, not well shown in the illustration. Fig. 3.—Wild yam (*Dioscorea villosa*), showing part of the vine, with its drooping clusters of flowers and 3-winged seed capsules; also the long, horizontal rootstock. Fig. 4.—Blue flag (*Iris versicolor*), showing sword-shaped leaves, the flowers, and part of the rootstock.

PLATE III. Fig. 1.—Large yellow lady's-slipper (*Cypripedium hirsutum*), showing plant with its broad, parallel-veined leaves, and curious, baglike flower, and also rootstock with wavy roots. Fig. 2.—Canada snakeroot (*Asarum canadense*), showing, to the right, the flowering plant, and to the left the fruiting plant, together with the creeping rootstocks. Fig. 3.—Virginia serpentaria (*Aristolochia serpentaria*), plant showing seed capsules and rootstock. Fig. 4.—Soapwort (*Saponaria officinalis*), showing the upper flowering portion and seed pods; also the runners and roots.

PLATE IV. Fig. 1.—Oregon grape (*Berberis aquifolium*), showing a branch with the leathery, holly-like leaves, and clusters of berries. Fig. 2.—Blue cohosh (*Caulophyllum thalictroides*), showing upper portion of the plant, with flowering head. Fig. 3.—Canada moonseed (*Menispermum canadense*), showing a portion of the vine in flower. Fig. 4.—Hydrangea (*Hydrangea arborescens*), showing a flowering and fruiting branch.

PLATE V. Fig. 1.—Indian-physic (*Porteranthus trifoliatus*), showing upper flowering portion, and base of stem with root. Fig. 2.—Wild sarsaparilla (*Aralia nudicaulis*), showing flowering plant with rootstock, and to the left a fruiting head. Fig. 3.—Ginseng (*Panax quinquefolium*), showing the upper portion in flower, and the root. Fig. 4.—Water-eryngo (*Eryngium yuccifolium*), showing the long, grasslike leaves, stout-stemmed flowering heads, and rootstock.

PLATE VI. Fig. 1.—American angelica (*Angelica atropurpurea*), showing leaves, fruiting head, and to the right a portion of the stem with broad, expanded leafstalk. Fig. 2.—Pinkroot (*Spigelia marilandica*), showing flowering top and seed capsules. Fig. 3.—Pleurisy-root (*Asclepias tuberosa*), showing flowering top, pods with escaping hairy seeds, and root. Fig. 4.—Comfrey (*Symphytum officinale*), showing the thick, rough leaves, the clusters of flowers, lower portion of plant with root, and sections of root.

PLATE VII. Fig. 1.—Stoneroot (*Collinsonia canadensis*), showing flowering top and base of stem with root. Fig. 2.—Queen-of-the-meadow (*Eupatorium purpureum*), showing leaves and flowers. Fig. 3.—Elecampane (*Inula helenium*), showing leaves, flowers, and root. Fig. 4.—Echinacea (*Brauneria angustifolia*), showing flowering plant.

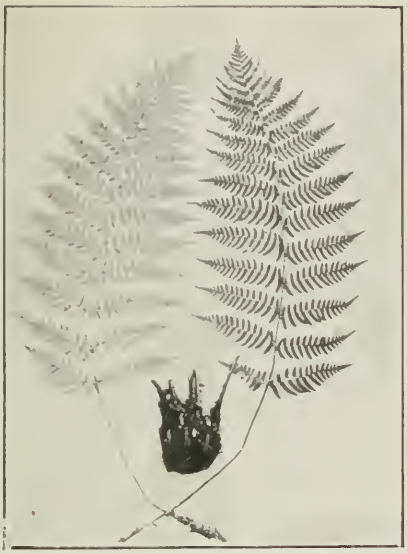

FIG. 1.—MARGINAL-FRUITED SHIELD-FERN (DRYOPTERIS MARGINALIS).

FIG. 2.—SKUNK-CABBAGE (SPATHYEMA FOETIDA).

FIG. 3.—SWEET-FLAG (ACORUS CALAMUS).

FIG. 4.—BETHROOT (TRILLIUM ERECTUM).

FIG. 1.—CHAMAELIRIUM (CHAMAELIRIUM LUTEUM).

FIG. 2.—ALETRIS (ALETRIS FARINOSA).

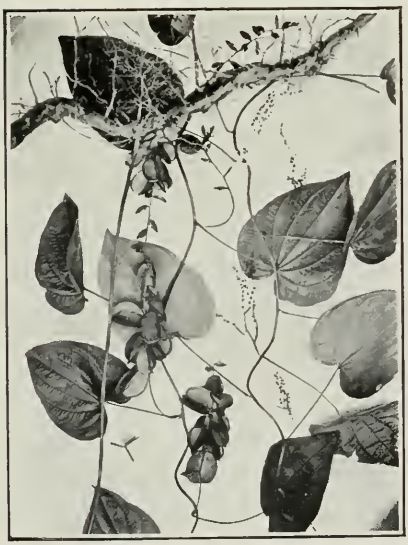

FIG. 3.—WILD YAM (DIOSCOREA VILLOSA).

FIG. 4.—BLUE FLAG (IRIS VERSICOLOR).

FIG. 1.—LARGE YELLOW LADY'S-SLIPPER (CYPRIPEDIUM HIRSUTUM).

FIG. 2.—CANADA SNAKEROOT (ASARUM CANADENSE).

FIG. 3.—VIRGINIA SERPENTARIA (ARISTOLOCHIA SERPENTARIA).

FIG. 4.—SOAPWORT (SAPONARIA OFFICINALIS).

FIG. 1.—OREGON GRAPE (BERBERIS AQUIFOLIUM).

FIG. 2.—BLUE COHOSH (CAULOPHYLLUM THALICTROIDES).

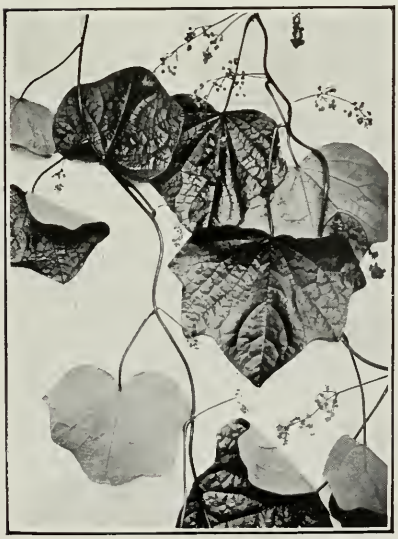

FIG. 3.—CANADA MOONSEED (MENISPERMUM CANADENSE).

FIG. 4.—HYDRANGEA (HYDRANGEA ARBORESCENS).

FIG. 1.—INDIAN-PHYSIC (PORTERANTHUS TRIFOLIATUS).

FIG. 2.—WILD SARSAPARILLA (ARALIA NUDICAULIS).

FIG. 3.—GINSENG (PANAX QUINQUEFOLIUM).

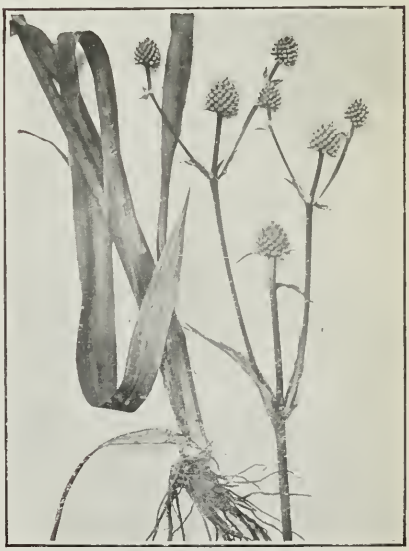

FIG. 4.—WATER-ERYNGO (ERYNGIUM YUCCIFOLIUM).

FIG. 1.—AMERICAN ANGELICA (ANGELICA ATROPURPUREA).

FIG. 2.—PINKROOT (SPIGELIA MARILANDICA).

FIG. 3.—PLEURISY-ROOT (ASCLEPIAS TUBEROSA).

FIG. 4.—COMFREY (SYMPHYTUM OFFICINALE).

FIG. 1.—STONEROOT (COLLINSONIA CANADENSIS).

FIG. 2.—QUEEN-OF-THE-MEADOW (EUPATORIUM PURPUREUM).

FIG. 3.—ELECAMPANE (INULA HELENIUM).

FIG. 4.—ECHINACEA (BRAUNERIA ANGUSTIFOLIA).

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BUREAU OF PLANT INDUSTRY—BULLETIN NO. 108.
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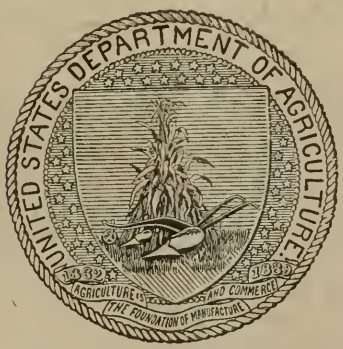
THE COLD STORAGE OF SMALL FRUITS.

BY

S. H. FULTON,

FORMERLY ASSISTANT POMOLOGIST, FIELD INVESTIGATIONS IN POMOLOGY.

ISSUED SEPTEMBER 9, 1907.



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STRAWBERRIES FROM COLD STORAGE

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U. S. DEPARTMENT OF AGRICULTURE.
BUREAU OF PLANT INDUSTRY—BULLETIN NO. 108.
B. T. GALLOWAY, *Chief of Bureau.*

THE COLD STORAGE OF SMALL FRUITS.

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BY

S. H. FULTON,

FORMERLY ASSISTANT POMOLOGIST, FIELD INVESTIGATIONS IN POMOLOGY.

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[a] Resigned in April, 1906.

LETTER OF TRANSMITTAL.

United States Department of Agriculture,
Bureau of Plant Industry,
Office of the Chief,
Washington, D. C., April 12, 1907.

Sir: I have the honor to transmit herewith a manuscript entitled "The Cold Storage of Small Fruits" and to recommend that it be published as Bulletin No. 108 of the series of this Bureau. This bulletin was prepared by Mr. S. H. Fulton, formerly Assistant Pomologist in Field Investigations in Pomology, and has been submitted by Messrs. William A. Taylor and G. Harold Powell, Pomologists in Charge of Field Investigations in Pomology, with a view to publication.

The subject is an important one to small fruit growers in many portions of the country, and it is believed that the results of the investigations set forth will be found useful by suggesting ways of prolonging the marketing season and thus conducing to a better distribution of the product, as well as by indicating some of the risks that are involved in attempts to hold such products longer than their inherent physical characteristics permit. The fundamental importance of careful attention to the details of harvesting, packing, and handling is emphasized by the results of this work, as well as the necessity of proper ventilation of rooms and isolation of products in storage houses to preserve the normal color, texture, and flavor of these delicate fruits.

The work covered by this report has been done by Mr. Fulton, while the investigations of the gases that accumulate in packages of stored fruit and of the effect of oxygen gas upon stored fruit have been made by Mr. H. C. Gore, of the Bureau of Chemistry, in cooperation with this Bureau.

The accompanying illustrations are necessary to a full understanding of the text.

Respectfully,

B. T. Galloway,
Chief of Bureau.

Hon. James Wilson,
Secretary of Agriculture.

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B. P. I.—284.

THE COLD STORAGE OF SMALL FRUITS.

INTRODUCTION.

The beneficial influence of cold storage on fruit growing in America has not been shared equally by all branches of the industry. Some kinds of fruit are better adapted to storing in cold temperatures than others, and are in active demand through a longer season. Winter apples and pears can be kept in good condition for long periods in cold storage, and a large part of the late apple and pear crops of the United States is now held in cold storage annually to insure a supply of these fruits in good condition throughout the winter and spring months. Upon the other hand, berries and other small fruits are not stored to nearly so great an extent on account of their highly perishable nature.

The storage of small fruits is a problem somewhat different from the storage of the more durable fruits. Winter apples and pears are usually too hard and immature when stored to be fit for immediate consumption. Cold storage insures the safe keeping of these fruits for long periods, and under proper management brings out their finest flavor and quality. The fruits ripen slowly in the low temperature of the storage house, the acids diminish, the starch changes to sugar if the transformation is not already completed when the fruit is stored, and the fine flavor and aroma of the fruit are developed.

In the storage of small fruits the conditions and purposes are different. The strawberry, for example, is usually developed to the highest state of perfection when picked; the quality is not improved by further ripening, and the fruit needs to be consumed quickly. All that can be hoped for from cold storage is to preserve for a short period the attractive appearance and fine flavor of the fruit.

In commercial practice, small fruits are sometimes stored for speculative purposes. The fruit is bought when the market is low; it is stored until prices advance, and it is then sold at a profit. Owing to the extremely perishable nature of most of the small fruits, however, this must be regarded as a hazardous practice. The great bulk of small fruits held in cold storage is placed there to protect the fruits temporarily from decay until they can be placed in the hands of the consumer. Shipments of small fruits are frequently delayed in transit

and reach their destination too late for the early morning market. There is often little opportunity of disposing of them until the following morning, or in case the late arrival occurs on Saturday the fruit can not be sold until the following Monday morning. Without artificial refrigeration, the fruit would deteriorate rapidly, and in many instances would become worthless before it could be sold. Under these conditions it may be saved by placing it temporarily in cold storage. An overstocked market sometimes results in the cold storing of considerable quantities of small fruits when there is a reasonable prospect for a stronger demand and better prices within two or three days.

Cold storage is now used for small fruits by many canning establishments. At the height of the season, the fruit is often received faster than it can be cared for. The surplus is then placed in cold storage to be held until it can be packed in the cans. Some of the best equipped canneries in this country are now supplied with their own cold-storage facilities.

In some sections, particularly in the Hudson River Valley of New York, small-fruit growers have built farm storage houses, cooled by ice or by a mixture of ice and salt, with a view to handling their crops to better advantage. The berries are placed in these houses as fast as picked, and held until the output of the day is ready for shipment. The fruit may be held from one day to the next before shipping, or even for a longer period if desired in the case of firm-fleshed varieties, and still reach the market in good condition. It has been found that berries cooled down before shipping will carry in better condition than they do when shipped in a warm condition.

Another phase of cold storage of small fruits that is assuming considerable importance is the freezing of the fruit for use by confectioners, bakers, and restaurateurs, the fruit being held in a frozen condition for use in ice cream, pastries, etc.

In view of the difficulties involved in storing and the long season during which fresh-picked supplies can be obtained from various sections of the country, the use of cold storage for small fruits will continue to be restricted mainly to the preservation of the fruit for a brief period when otherwise it would be lost. But in this field alone cold storage serves a very important mission, for in many of the large cities of the country great quantities of berries are annually stored for brief periods for one or more of the reasons already stated. In New York, for example, thousands of crates of berries are sometimes stored in a single day in the cold-storage houses within or near the produce district.

There is very little information published relative to the cold storage of small fruits, and such as is available is based primarily upon obser-

vation of the conditions surrounding the fruit in the cold-storage house. Little consideration appears to have been given the conditions surrounding the growing and handling of the fruit, though these conditions very largely determine the behavior of all kinds of fruits in cold storage. The only record of a systematic test of the keeping of small fruits in cold storage which has come under our observation is a report of a series of experiments performed in England in 1898. The results of this test are given in the Journal of the Board of Agriculture of Great Britain for June, 1899 (p. 85), under the title "Cold Storage of Fruit." Extracts from this article are here given:

The board of agriculture have received from the Kent County council a report by Mr. W. P. Wright, F. R. H. S., superintendent of horticulture under the technical education committee, upon the results of experiments on the cold storage of fruit. Three cold chambers were used, each fitted with two brine walls or flat tanks placed in close proximity to the insulated sides of the chamber; through these tanks brine cooled by a carbonic anhydride refrigerating machine was circulated at any desired temperature. Each chamber was fitted with tiers of galvanized wire shelves around the sides, and the fruit was placed on these under three different conditions: (1) Exposed on the shelves, (2) enveloped in grease-proof paper, (3) surrounded or covered by cotton-wool. It was found that strawberries could be kept for at least three weeks in a temperature of 30°, but it was necessary to surround the fruit with cotton-wool, or, in the case of fruit in sieves, to place a pad of that material over the top. When this precaution was not taken, the fruit, though sound, became dull and lost the fresh, inviting appearance which is so important when it is offered for sale. Black currants kept well for ten days, after which they began to shrivel, but plumped and freshened on exposure to the air so as to be marketable. This was especially the case with black currants that had been stored in market sieves covered with a wad of cotton-wool. After a fortnight's storage, the temperature was raised from 30° to 32° F., and this seemed to give the best results. The experiments with red currants were an unqualified success, the fruit remaining perfectly sound for six weeks, and maintaining its freshness when exposed to a normal temperature for sixteen hours. Cherries covered with wool kept for a month at a temperature of 30°, and at 36° were not only sound, sweet, and juicy, but fresh and clear. After the fourth week the fruit began to wrinkle.

The small fruits above mentioned, and particularly strawberries, must, it appears, be placed in store in advance of dead ripeness; when fully ripe they will keep for some time, but lose surface freshness; the fruit must be sound, and not pecked or injured in any way. * * *

In concluding his report Mr. Wright observes that, in his opinion, people do not quickly weary of high-class fruit, and a longer season than at present exists could be secured for many kinds if the best quality were ensured; but, apart from this, there are periods within the season of several perishable fruits—black currants, for instance—when ability to hold the pickings over, if only for a few days, would mean securing an enhanced price.

The results of this test agree in general with the results obtained through the cold-storage experiments of the United States Department of Agriculture as to length of time small fruits may be kept in cold storage.

OUTLINE OF EXPERIMENTS IN SMALL-FRUIT STORAGE.

Since September, 1901, many problems relating to the cold storage of fruits have received attention in connection with the field investigations in pomology of the Bureau of Plant Industry. For three years of this period the small fruits have been given special attention.

In these experiments the factors affecting the keeping of small fruits in cold storage, such as the influence of soil and climatic conditions, the time of picking, the methods of handling, the types of packages, wrappers, and the temperatures in the storage house have been under investigation. The effect of cold storage on the flavor and aroma of the fruit and the behavior of the fruit when withdrawn from storage have also received consideration.

Subsequent investigations of the Bureau of Plant Industry will bear upon a number of these problems, and while the principles laid down in this publication as a result of the tests are believed to be correct, they may be modified more or less by the additional light afforded by subsequent experiments. This report, therefore, should be regarded as preliminary rather than as conclusive and final.

The principal varieties of small fruits used in the experiments are as follows: Johnson Early, Tennessee, and Gandy strawberries; Early Harvest and Erie blackberries; Miller, Kansas, and Doolittle raspberries; Lucretia dewberries; Howard Bell cranberries; Versaillaise currants, and Houghton gooseberries. From eight to twenty-four 16-quart crates of each variety were generally used in each season's test. These fruits, with the exception of the cranberries, which were obtained from a New Jersey grower, were furnished by a number of small-fruit growers in Alexandria and Fairfax counties, Virginia. The fruit was brought to Washington by wagon, all of the growers being located within 8 to 10 miles of the storage house, and was stored from four to eight hours after picking in the cold-storage department of the Center Market, at Washington, D. C.

The names of the several small-fruit growers from whom fruit was procured, and the principal varieties furnished by each, are as follows:

Brown, J. K., Alexandria, Va., Versaillaise currants, Houghton gooseberries, and Early Harvest blackberries.

Durell, E. H., Bell Plain, N. J., Howard Bell cranberries.

Leonard, David, Westend, Va., Gandy and Tennessee strawberries, and Kansas raspberries.

Sherwood, D. C., Westend, Va., Tennessee strawberries, Doolittle and Miller raspberries, Lucretia dewberries, and Erie blackberries.

Shreve, R. E. T., Westend, Va., Johnson Early strawberries.

Sprankle, W. T., Falls Church, Va., Early Harvest blackberries.

Most of the fruit used in these experiments, except the cranberries and one series of Gandy strawberries, which were grown upon clay soil, was grown upon reddish, gravelly loam soil with clay subsoil, at an altitude of a little more than 100 feet above sea level.

The fruit, with the exception of the cranberries (which were in barrels and boxes), was packed in the open-slat crates commonly used in the middle and southern berry-growing districts, and also for contrast in the closer, more compact Hallock crate used in the berry sections of Michigan and other western States. For the purpose of testing the effect of a close package, some of the fruit was also packed in paraffined paper cartons wrapped with a calendered paper jacket. Two of these packages are shown in Plate II, figure 1. During the season of 1905 some of these cartons were wrapped in heavy paraffin paper, the whole being then inclosed in the paper jacket. The effect of wrapping was also tested both by wrapping each box or basket separately in thin, impervious japanin paper and by wrapping the entire crate in heavy manila paper.

Upon arrival at the storage house, part of the fruit of a number of the pickings was delayed a few hours in the corridors before it was placed in the storage room, while the remainder was stored at once. The fruit was stored in two temperatures, namely, 36° and 32° F. Samples of each lot were held out of storage to compare with the cold-stored fruit.

THE INFLUENCE OF SOIL AND CLIMATIC CONDITIONS ON THE KEEPING QUALITY OF SMALL FRUITS.

These experiments indicate that the character of the soil may influence the keeping quality of small fruits to some extent, though the data along this line are only suggestive. Berries grown to a large size upon low, moist, clay loam, for example, usually began to break down more quickly than the same variety grown to a somewhat smaller size upon the moderately dry gravelly loam. No comprehensive test of the influence of soil types on the keeping of the fruit has been undertaken.

The keeping quality of small fruits is quickly affected by changes in climatic conditions. Berries ripening during a period when the supply of moisture is favorable for the development of sound, healthy fruit, keep better than the same variety stunted by drought or overgrown by excessive rainfall. Strawberries of the Tennessee variety in 1903 kept poorly when picked during a drought at the opening of the season, but following two days of rainy weather, which supplied a sufficient amount of moisture, the fruit kept well for seven to ten days. After eight days of rainy weather, however, the fruit was overgrown and soft when stored, and after five days in storage was worthless.

Some varieties are much more easily affected by excessive rains than others. The Tennessee strawberry, for example, will be softened and rendered almost unmarketable by a rainfall which would not seriously affect the Gandy variety.

THE INFLUENCE OF THE TIME OF PICKING ON THE KEEPING QUALITY OF SMALL FRUITS.

Small fruits designed for cold storage should be picked when well matured and fully colored, but while still in firm condition. If harvested in an immature condition the flavor is poor and insipid, as immature fruit does not develop properly after picking. This being the case, small fruits for cold storage should be practically as well matured when picked as fruit that goes directly to market for immediate consumption.

In the case of nearly all varieties of berries used in the experiments, three pickings were made for storage, the first early in the season of the variety, the second at the height of the season, and the third as late in the season as a good picking could be secured. No difference in the keeping of the fruit from the several pickings could be detected, providing the weather and other conditions were uniform throughout the season of the variety.

STORAGE HOUSE TEMPERATURES FOR SMALL FRUITS.

In these investigations considerable quantities of small fruits have been stored in duplicate lots in temperatures of both 32° and 36° F. At the lower temperature the fruit has kept in firm condition longer, was somewhat less affected by mold, and held up equally as well or better after withdrawal from the warehouse than that stored in a temperature of 36° F. Unless the fruit was stored for a period of four or five days or longer these differences did not become noticeable.

The impression held by many warehousemen and fruit handlers that low temperatures (32° to 33° F.) are injurious to berries and other quick-ripening fruits has not been borne out by these investigations. Gandy strawberries of the crop of 1903 kept twenty-one days in a temperature of 32° F. and retained their bright, attractive appearance to a remarkable degree. The condition of the fruit after twenty-one days in cold storage is shown in Plate I, *A*. Other varieties have kept equally well for a somewhat shorter period. No discoloration of the flesh of any of the varieties has occurred as a result of the lower storage temperature.

Small fruits are stored in most warehouses at temperatures ranging from 35° to 40° F. These temperatures give satisfactory results if the fruit is to be stored not longer than two to three days. If, however, the fruit is stored for a longer period of time a temperature of about 32° F. will preserve it in better condition.

THE FREEZING OF SMALL FRUITS IN COLD STORAGE.

In some of the large cities the practice of freezing small fruits for the purpose of holding them indefinitely in a frozen condition to be used in making ice cream and pastries has recently come into use to a limited extent among confectioners, bakers, and restaurateurs. Much of the fruit used for this purpose is bought when the market price is low, such as on Saturday evenings or when the market is glutted. It is hurried into cold storage and is frozen at a temperature ranging from about 5° to 12° F. This fruit is used during the normal small-fruit season, if necessary, or may be held to prolong the season for several weeks, or even months in the case of some of the small fruits. By freezing the fruit a large amount may be kept on hand, thereby avoiding the danger of a temporary shortage in the supply. Some restaurateurs who formerly made a practice of packing berries in dry granulated sugar and of holding them at a temperature of 31° to 32° F. have now given up this practice and have adopted the freezing method.

If the fruit is intended for long preservation it is usually placed in loosely covered tin cans to prevent evaporation, but if it is to be kept a short time it is frequently stored in the ordinary crates in which it is conveyed to market. In the tests of the Bureau of Plant Industry of 1904–5 Gandy strawberries were frozen and held at a temperature of 10° to 14° F. for ten months in the tight paper-wrapped cartons of paraffined cardboard already mentioned, with very little change in color and practically no shrinkage. The condition of berries that had been in storage over seven months in a temperature of 10° F. is shown in Plate I, *B*. Berries frozen in open crates at the same time evaporated and shrunk away fully one-half within a few months.

In June, 1905, strawberries of the Gandy and Tennessee varieties and Miller and Kansas raspberries were frozen and stored in different styles of packages in a temperature of 12° F. in a general freezing room containing meats, poultry, game, etc. The packages used were (1) the paper-wrapped paraffined cardboard carton shown in Plate II, figure 1; (2) the same carton with an additional heavy paraffined paper wrap over the cardboard, which with the outside paper jacket constituted a triple-thick carton; and (3) the common open slat berry crate used in this section. This fruit was still normal in appearance on January 12, 1906, except for a slight fading in the color of the strawberries and a slight shrinkage of both strawberries and raspberries in the open crates. The fruit in the closed packages was plump and attractive in appearance. The flavor of the fruit of both strawberries and raspberries in the open crates was not good. Apparently the fruit had absorbed odors from other articles in the storage room.

The flavor of the fruit in the triple box was a little better, but it had evidently been tainted through the effect of the carbon-dioxid gas exhaled by the fruit before it was solidified in freezing. The flavor of the fruit in the double-wrapped carton, however, which was not so impervious to the air, was not contaminated, and it retained much of the sprightliness and flavor of the fresh fruit. This test seems to indicate that for frozen fruit, as in the case of fruit stored at a temperature above the freezing point, the best results can be obtained by the use of a close package, provided the package is not so tight as to prevent the escape of the gases given off by the fruit after it is packed and before it is frozen.

Frozen strawberries for ice cream have been in use in a limited way by confectioners for some time, while frozen blackcap raspberries, currants, blackberries, huckleberries, and other small fruits are now being used successfully for pies and other pastries by a few restaurateurs and bakers. A large pie bakery in a central western city is successfully using frozen blackcaps, gooseberries, blackberries, currants, and huckleberries in large quantities. When made into pies the flavor of the frozen fruit is said to be practically equal to that of fresh fruit. Considerable quantities of cherries and damson plums are also frozen by this company for use in pies. Usually these latter fruits are put into the pies whole without seeding. Sometimes they are dipped in cold water to take out the frost and then are pitted. Frozen cherries and plums shrivel somewhat in baking, and are therefore not used so successfully as some of the berries. Frozen strawberries have not been used for pies to any extent, as they are likely to soften unduly in baking. Frozen huckleberries and currants can be easily and successfully held for many months. In 1905 the firm referred to above froze 14 carloads of huckleberries, using the fruit in pies for months after the fresh fruit had disappeared from the markets.

THE INFLUENCE OF THE TYPE OF PACKAGE ON THE KEEPING QUALITY OF SMALL FRUITS.

In these experiments, the Hallock crate commonly used in the berry districts of Michigan and other Central Western States was tested in comparison with the open slat crate, with flaring baskets, used throughout the berry sections of the Middle and Southern States. Baskets used in the open-slat crates are shown in Plate III, figures 1 and 3. The Hallock crate holds 16 square quart boxes, made of veneer with raised bottoms, and is a somewhat tighter package than the slat crate. A Hallock crate is shown in Plate II, figure 3. The Hallock box, shown in Plate II, figure 2, is also much tighter than the berry

basket used in the eastern crate. These two crates are the standard berry packages for the eastern United States. A series of tests developed the fact that not enough difference in the tightness of the two packages exists to materially affect the keeping of the fruit in cold storage. Practically the same amount of mold developed in the fruit in one package as in the other, and neither seemed superior to the other in affecting the length of time the fruit kept.

With a view to testing the effect of a close package upon the keeping of berries in cold storage, a considerable quantity of fruit was stored in the cartons before mentioned. The carton used holds a little less than a quart, and is manufactured and used by a confectionery firm for the purpose of preserving pop corn and other confections in a dry, crisp condition. The package is a very close one, well designed for protecting the contents from contact with the air. Fruit packed in these boxes in a dry, firm condition kept well, being much less affected by mold and less tainted by storage-house odors than the fruit stored in open packages. Fruit that was damp with rain or dew when packed, however, fermented and turned brown in three or four days. A still tighter package, made by wrapping and sealing the paraffined cardboard carton in a heavy paraffined paper wrap before inclosing it in the outside paper jacket, was tested during the season of 1905. This package proved too tight; the fruit softened and had the characteristic bad flavor of fruit confined and smothered in an atmosphere of carbon dioxid.

COMPOSITION OF THE AIR IN DIFFERENT TYPES OF PACKAGES.

In order to test the comparative tightness of the several packages and to determine the effect of a close package on the air surrounding the fruit, a series of chemical tests of the air in the packages was made in cooperation with Mr. H. C. Gore, assistant chemist, in the Bureau of Chemistry. Packages of fruit were prepared in the berry field and were placed in cold storage at 36° F. two to four hours later. The packages used were the double-wrapped and the triple-wrapped cartons previously described and glass bottles with rubber stoppers. Within four to ten days after the fruit was stored Mr. Gore analyzed samples of the gases taken from the several styles of packages.

The method of taking the samples of gas was as follows: A round hole was punched in one end of the box and a glass tube was immediately inserted nearly the whole length of the box. This glass tube was connected with a rubber tube attached to a 6-ounce bottle. The bottle, rubber tube, and glass tube had been previously filled with water. By gentle suction a sample of air 60 to 80 cubic centimeters in volume was drawn from the package and was immediately analyzed. In taking samples from the bottles the glass tube of water was inserted through

an opening made by removing a glass plug from the stopper of the bottle. By these methods of taking the gas samples some admixture with the outside air is possible, but it was evidently not sufficient to vitiate the results in a comparative study of this kind. Table I shows the result of these analyses.

TABLE I.—*Analyses of gas in strawberry packages.*

Variety.	Date of picking.	Date of analysis.	Volume of sample analyzed.	Character of wrapper.	Carbon dioxid found.	Oxygen found.
	1905.	1905.	*Cubic centimeters.*		*Per cent by volume.*	*Per cent by volume.*
Gandy	June 5	June 15	62.2	Double wrapper	2.09	17.5
Do	do	do	86.0	do	1.86	18.6
Do	June 9	do	73.7	do	1.49	20.0
Do	do	do	100.0	do	1.40	18.8
Do	do	do	78.2	Triple wrapper	9.8	12.8
Do	do	do	100.0	do	7.16	13.6
Do	June 16	June 19	100.0	Tightly closed bottles	37.2	0
Do	do	do	86.4	do	36.3	0.2
Do	do	do	100.0	do	37.6	0
Do	do	do	63.4	do	34.3	0
Average for tightly closed bottles					36.4	

It will be seen from the above table that the samples taken from the ordinary double-wrapped cartons show a low percentage of carbon dioxid and a high percentage of oxygen. This indicates that the double-wrapped package is not very tight, comparatively speaking, as the amount of carbon dioxid retained increases with the tightness of the package. The samples taken from the triple-wrapped carton show much more carbon dioxid and much less oxygen, indicating that the triple-wrapped package is much tighter than the double-wrapped package. The samples taken from the tightly stoppered glass bottles show a still larger percentage of carbon dioxid and an almost entire lack of oxygen, indicating a high degree of tightness. In these receptacles practically all of the oxygen in the confined air was replaced by carbon dioxid, and about 15 per cent in addition was produced by the fruit.

The flavor of the fruit in the double-wrapped boxes was very good at the time the gas samples were taken, and the berries were still firm and sound. In the triple-wrapped box the fruit had softened considerably and had a bad flavor. The fruit in the glass bottles was softer than that in the triple-wrapped boxes and the flavor was very bad. The poor flavor, together with the softening of the texture, was undoubtedly due to the smothering of the fruit by the large amount of carbon-dioxid gas.

A fruit as taken from the tree or plant is a living, breathing organism. It takes in oxygen and gives off carbon dioxid. It can not be held in a tight package in an atmosphere of carbon dioxid exhaled by the fruit itself without killing it or injuring it severely. This is appar-

ently what occurred in the triple-wrapped cartons and in the glass bottles. However, in the practical application of a close package to fruit storage, smothering would not be likely to occur, as a package tighter than the double-wrapped box would rarely, if ever, be used. Fruit appears to be damaged little, if any, in keeping quality or in flavor by the presence of a small amount of carbon dioxid in the air of the storage room, and only in the presence of a large amount of this gas does real injury occur. Commercial packages which are generally used in storing fruit are not sufficiently tight to retain a considerable amount of carbon dioxid. There might be some injury in a moderately close package if the fruit was not stored quickly after it was picked and packed. The life processes of the fruit are much accelerated at this time, particularly in warm weather, and under these conditions enough carbon dioxid might be given off and retained by the package to injure the quality of the fruit before it was stored. In cold storage, however, the life processes are retarded quickly by the low temperature, respiration progresses much more slowly, less carbon dioxid is given off, and therefore there is less danger of injury from this source.

THE INFLUENCE OF THE WRAPPER ON THE KEEPING QUALITY OF SMALL FRUITS.

At the present time no tight berry package is manufactured. A few northern growers are using paper wrappers on berry boxes, which is a step in the direction of a close package. In the tests of the Bureau of Plant Industry impervious japanin paper was used upon a considerable quantity of fruit stored, each box being wrapped separately. Berry boxes wrapped in japanin paper are shown in Plate II, figures 2 and 3. The wrapper aided materially in retaining the bright color and attractive appearance of the fruit and prevented the absorption of storage-house odors to a marked degree. It also retarded to some extent the appearance of mold. In preventing the tainting from storage-house odors alone, the moderately tight package or the use of the wrapper has proved of great value.

During the season of 1905 a test of wrapping crates of strawberries of the Gandy and Tennessee varieties in heavy manila paper was made, the entire crate being covered with paper instead of wrapping the individual baskets. While this treatment did not result in materially diminishing the amount of mold which developed on the fruit, it did prove efficient in preventing the tainting of the fruit from storage-house odors. Berries in adjoining unwrapped packages became so contaminated with odors from other products in the storage room that the fruit was quite unpalatable in a few days, while the berries in the wrapped crates remained entirely free from such contamination.

Aside from the protection afforded berries by its use, the wrapper also adds to the attractiveness of a berry box. The idea of rendering the package more attractive has probably been the dominating one with the berry growers who have made use of the wrapper, but, as previously shown, its usefulness does not end with its esthetic value.

In commercial cold storage, single rooms in storage houses are frequently used for a wide range of commodities during the summer months. It is not uncommon to find vegetables of various kinds and even citrus fruits stored in the same room with berries. In a poorly ventilated room, the odors arising from these products are quickly absorbed by the berries, rendering the flavor of the fruit objectionable. The fruit lacks wholesomeness, and is therefore objectionable to the consumer, though it may be bright in color and of sound physiological condition.[a]

THE INFLUENCE OF OXYGEN GAS ON THE KEEPING QUALITY OF SMALL FRUITS.

As the keeping quality of the small fruits was injured when they were stored in an atmosphere containing an excess of carbon dioxid, some tests were made by Mr. Gore to determine the influence of storing strawberries and raspberries in an atmosphere containing an excess of oxygen.

The strawberries used for the test were of the Gandy variety. A few berries were soft when stored, but most of the fruit was firm and dry. Several boxes were exposed to the usual conditions of the open package, and several were kept in a large glass bell jar, which closely fitted a ground glass plate. The air in this jar was then displaced with oxygen of 90 to 95 per cent purity, and was renewed at intervals

[a] The factors that influence the wholesomeness of a fruit in cold storage are complex in nature. It is generally supposed that good quality is determined principally by the length of time the fruit has been stored. The question, however, is more complicated than this. The physical condition and flavor of the fruit at any period in its storage life may be influenced by the weather conditions surrounding it before it is stored or by a delay in storing the fruit, both of which may cause it to expend a large part of its life before it is stored; they may be modified by the relation the package or wrapper bears to the proper ventilation of the fruit or to the exclusion of the impure air of the storage house; they may be modified by the rapidity of cooling the produce after it is placed in the warehouse, by the relation of the storage-house temperature to the life processes of the fruit, by the ventilation of the warehouse, and finally by the effect of the length of time the fruit is in storage on all of these factors. Until recently little attention has been paid to the factors that affect the wholesomeness of cold-storage fruits, except the length of time a product is stored and the temperature in which it is stored in the warehouse. The work of the Bureau of Plant Industry along fruit-storage lines has emphasized the fact that the question is much broader than is generally believed and that it needs careful experimental consideration from several standpoints.—G. H. P.

of two to four days throughout the experiment. After an interval of sixteen days the jars were opened and the fruit compared with that stored in the exposed boxes.

The fruit held in oxygen had a good color and flavor, but had softened so as to be entirely unmarketable. It was free from black mold. The fruit held in open boxes had a good color, but a bad flavor, and it was badly molded. It was unmarketable. The difference between the two lots was about that which occurs when the fruit is stored for the same length of time in open and closed packages. No effect due primarily to the oxygen gas was apparent.

For the raspberry test, Kansas blackcaps were used. The fruit was in first-class condition, dry and firm, when stored. Several boxes were left under the usual storage conditions, several were kept in a bell jar in confined air, and several were kept in a bell jar in oxygen, the gas being frequently renewed. After an interval of thirty-nine days the fruit was examined. The berries in the open boxes had sunk down so that they filled the boxes not more than half full. They had molded badly. The fruit confined in air in the bell jar was in good physical condition. The berries were dry and free from mold. The flavor, however, was insipid. The fruit kept in oxygen was also in good physical condition. The berries were dry and free from mold, but the flavor was quite insipid. No effect attributable to the presence of oxygen was brought out. As in the case of the strawberries, the better condition of the inclosed fruit over that of the exposed fruit was due apparently to the influence of the close receptacle.

THE INFLUENCE ON THE KEEPING QUALITY OF CAREFUL HANDLING AND OF STORING SMALL FRUITS SOON AFTER PICKING.

The most serious troubles with small fruits in cold storage are the quick loss in flavor when they are stored in impure air, the softening of the fruit from overripeness, and the molding or decay, especially of raspberries, strawberries, blackberries, dewberries, and currants. The mold usually appears a few days after the fruit is stored. It is a fungus called *Botrytis vulgaris*, commonly known as black mold. Molded berries are shown in Plate I, *D*, and in Plate III. It is especially serious in small fruits that have been handled roughly and that are not stored soon after picking. A berry picked in a dry, sound, firm condition is not often attacked by the black mold. Overripe berries and berries with the surface bruised nearly always mold. The mold gains entrance through the bruised or weakened parts of the fruit, creeping over the berries in the form of a cotton-like covering or mycelium. It grows luxuriantly in warm temperatures and slowly in the coldest temperatures in which the fruit can be stored safely without freezing. It is most troublesome on raspberries.

The most successful method of preventing this trouble is to store only sound, firm berries. To prevent the trouble is primarily a problem of picking and handling. It is necessary that the pickers do not injure the berries, and that they be handled through every operation from the crating to the market with enough care to prevent the bruising of the delicate fruit. A large proportion of the commercial losses in the shipping and handling of small fruits is the direct result of the rough handling which makes them susceptible to mold or decay.

In addition to the loss from mold, the bruised portions of small fruits quickly discolor in the storage house, as shown in the frontispiece, Plate I, *C* and *D*.

Quick storage or cooling after picking is an equally important requirement in small-fruit storage. The life processes need to be checked at the earliest possible moment to prevent overripeness and to conserve the flavor of the fruit by preventing the giving off and accumulation of carbon dioxid and the absorption of odors from the surrounding air. The fruit needs to be cooled quickly, also, to retard the growth of the molds already mentioned. If the fruit stands in the field or in a packing house or at a railroad station for some time before loading, if it is hot when loaded and is shipped by express or by freight without ice, if it is not cooled down quickly in the car when shipped in refrigeration, or if the fruit is held in the market for some time after arrival it is impossible to place it in cold storage without the subsequent development of bad flavor, overripeness, and moldy or decayed fruit.

THE LENGTH OF TIME SMALL FRUITS KEEP IN COLD STORAGE.

The length of time small fruits keep in cold storage depends upon the variety, the conditions under which the fruits are grown, and the methods of handling them in picking, packing, shipping, etc. In the Department tests, with fruit handled under good commercial conditions, strawberries kept from one to two weeks in good condition so far as appearances were concerned, but the flavor usually began to deteriorate after three or four days. Some of the firm-fleshed varieties, like Gandy, kept even longer than two weeks when picked dry and carefully handled, while tender varieties, like Tennessee, went down much more quickly. Red raspberries usually began to mold after two or three days in storage. Black raspberries kept in sound condition for a somewhat longer period. Most varieties of blackberries kept a week, while some of the firmer fleshed sorts kept several days longer. Dewberries behaved similar to blackberries. Currants kept well for two weeks with slight loss of flavor. Gooseberries retained their normal appearance and flavor for two to three weeks, after which the fruit

turned red and became unsalable. Cranberries kept throughout the winter and were withdrawn the last of April in good commercial condition.

These statements are based upon tests with small fruits packed in the customary way as for market and stored in a temperature of 32° F. Wrapped fruit and fruit stored in moderately tight packages kept for somewhat longer periods.

THE BEHAVIOR OF SMALL FRUITS WHEN WITHDRAWN FROM COLD STORAGE.

Small fruits do not hold up long after withdrawal from cold storage on account of their highly perishable nature. In the tests of the Bureau of Plant Industry strawberries, raspberries, and blackberries which had been stored for several days usually began to break down within six to sixteen hours after removal from storage, while currants and gooseberries held up from twelve to twenty-four hours, or even longer.

Small fruits need to be placed in the hands of the consumer as quickly as possible after removal from cold storage. If disposed of quickly after withdrawal, small fruits which have not been stored too long or subjected to unfavorable conditions in handling or storing will be in wholesome condition about as long as fruit in similar condition of ripeness and soundness that has not been in cold storage.

SUMMARY.

Cold storage has not exerted so important an influence upon the development of the small-fruit business as upon the growing of apples, pears, and other tree fruits. Small fruits are not adapted to keeping for any length of time in cold storage.

Most of the small fruits are held in cold storage to protect them from decay, usually not more than two or three days, until they can be placed in the hands of the consumer.

Nevertheless cold storage is a factor of no small importance in the handling of the small-fruit crop. Shipments of small fruits reaching destination too late for the early morning market are usually placed in cold storage until the following morning. Large quantities of small fruits are stored for two or three days when the markets are glutted and when prospects are good for an advance in prices. Many canneries are equipped with cold storage plants for use in preserving berries and other fruits until they can be utilized. In some sections small farm storage houses are used in connection with the handling of small fruits. Small fruits are sometimes stored in a frozen condition

for weeks and even months for use by confectioners, bakers, and restaurateurs.

Berries grown to a large size upon low, moist soil usually begin to break down more quickly in cold storage than the same varieties grown to a somewhat smaller size upon light, dry soil.

Berries ripening during a period when the supply of moisture is favorable for a sound, healthy development of fruit keep better than the same varieties stunted by drought or overgrown on account of excessive rainfall.

Small fruits designed for cold storage should be picked when well matured and fully colored but while still firm.

There is no apparent difference in the keeping of small fruits from early, medium, and late pickings.

Small fruits must be handled quickly and with great care in the field and on the way to the storage house to prevent ripening, the bruising of the fruit, and the development of mold.

If the fruit is to be stored for two or three days, a temperature of 36° to 40° F. will ordinarily give satisfactory results, though a temperature of 32° F. is to be preferred. If the storage period extends over a week or more, a temperature of 30° to 32° F. will be found more effective.

When frozen for long keeping, small fruits are usually subjected to a temperature of 5° to 12° F.

Frozen strawberries to be used in ice cream have been in use in a limited way by confectioners for some time, while frozen raspberries, currants, blackberries, huckleberries, and other small fruits are now used successfully for pies and other pastries by a few restaurateurs and bakers.

Strawberries and raspberries were stored in close paper cartons lined with paraffined cardboard. Some of these cartons were made extra tight by the use of a paraffined paper wrap placed over the cardboard liner of the carton. The cartons without the extra wrap preserved the fruit in good, sound condition, freer from mold and tainted less by storage-house odors than fruit stored in open packages. With the extra wrap the cartons proved too tight; the fruit softened and had the characteristic bad flavor of fruit confined in an atmosphere of carbon dioxid.

Wrapping baskets of berries in thin impervious paper aids materially in retaining the bright color and attractive appearance of the fruit, prevents the absorption of storage-house odors to a marked degree, and retards to some extent the appearance of mold.

Strawberries were kept in good condition in cold storage from one to two weeks; red raspberries, two to three days; black raspberries,

three to five days; blackberries and dewberries, from a week to ten days, and currants, two to three weeks. Cranberries kept all winter.

Strawberries, raspberries, and blackberries which have been stored for several days usually begin to break down within ten to twelve hours after removal from storage, while currants and gooseberries hold up from twelve to twenty-four hours longer.

Upon removal from cold storage small fruits should be placed in the hands of the consumers as soon as possible.

PLATES.

DESCRIPTION OF PLATES.

PLATE I. *Frontispiece.* Gandy strawberries. *A* shows the condition of the fruit after twenty-one days in cold storage at a temperature of 32° F. The fruit was firm, bright, and normal in appearance on withdrawal from the storage house, but the flavor was gone. *B* shows the condition of the fruit after more than seven months in cold storage in a frozen condition at a temperature of 12° F. *C* shows the discoloration of the fruit from bruising. *D* shows mold growing over a bruised spot.

PLATE II. Packages and wrappers used on berries in cold storage. Fig. 1.—Cartons in which berries were frozen. Fig. 2.—Strawberries wrapped with japanin paper and a box of unwrapped fruit. Fig. 3.—Black raspberries in a Hallock crate, unwrapped and wrapped with japanin paper.

PLATE III. Black mold on strawberries and black raspberries in cold storage. Figs. 1 and 2.—Black raspberries showing mold in cold storage. Figs. 3 and 4.—Black mold on strawberries in cold storage. The white mycelial threads holding the berries together and spreading over them are shown.

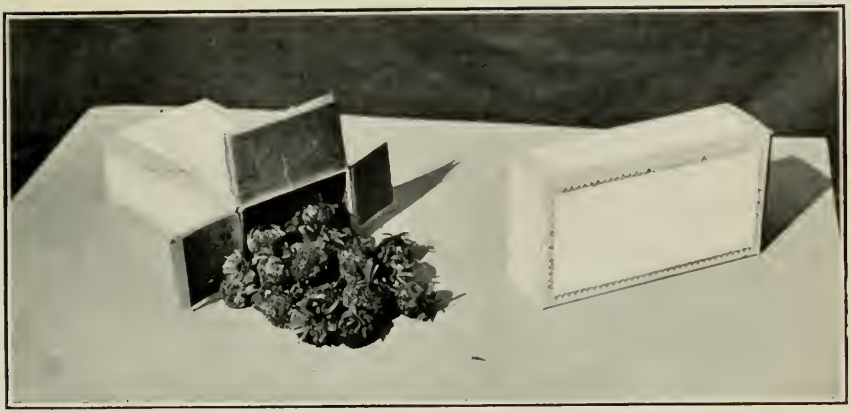


FIG. 1.—CARTONS IN WHICH FRUIT WAS FROZEN.

FIG. 2.—A BOX OF STRAWBERRIES WRAPPED WITH JAPANIN PAPER AND ONE UNWRAPPED.

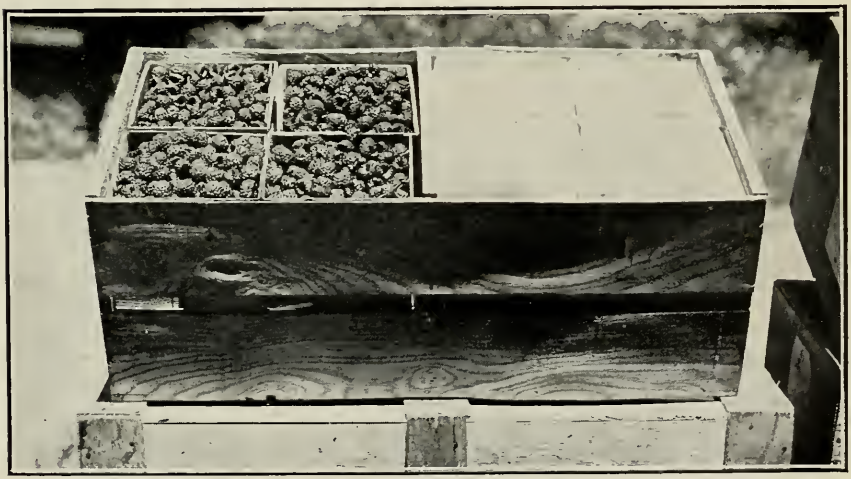
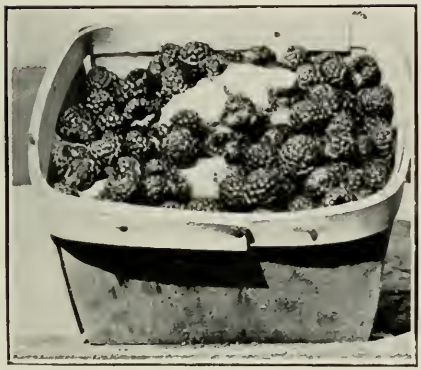


FIG. 3.—BLACK RASPBERRIES WRAPPED IN JAPANIN PAPER AND UNWRAPPED, PACKED IN A HALLOCK CRATE.

PACKAGES AND WRAPPERS USED ON BERRIES IN COLD STORAGE.



FIGS. 1 AND 2.—BLACK MOLD ON BLACK RASPBERRIES.

FIGS. 3 AND 4.—BLACK MOLD ON STRAWBERRIES.

BLACK MOLD ON STRAWBERRIES AND BLACK RASPBERRIES IN COLD STORAGE.

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U. S. DEPARTMENT OF AGRICULTURE.

BUREAU OF PLANT INDUSTRY—BULLETIN NO. 109.

B. T. GALLOWAY, *Chief of Bureau.*

AMERICAN VARIETIES OF GARDEN BEANS.

BY

W. W. TRACY, JR.,

ASSISTANT BOTANIST, VEGETABLE TESTING GARDENS.

ISSUED SEPTEMBER 9, 1907.

WASHINGTON:

GOVERNMENT PRINTING OFFICE.

1907.

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The scientific and technical publications of the Bureau of Plant Industry, which was organized July 1, 1901, are issued in a single series of bulletins, a list of which follows.

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U. S. DEPARTMENT OF AGRICULTURE.

BUREAU OF PLANT INDUSTRY—BULLETIN NO. 109.

B. T. GALLOWAY, *Chief of Bureau.*

AMERICAN VARIETIES OF GARDEN BEANS.

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BY

W. W. TRACY, JR.,

ASSISTANT BOTANIST, VEGETABLE TESTING GARDENS.

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LETTER OF TRANSMITTAL.

U. S. Department of Agriculture,
Bureau of Plant Industry,
Office of the Chief,
Washington, D. C., April 19, 1907.

Sir: I have the honor to transmit herewith a technical paper entitled "American Varieties of Garden Beans," prepared by W. W. Tracy, jr., Assistant Botanist, Vegetable Testing Gardens, and to recommend that it be published as Bulletin No. 109 of the series of this Bureau.

In Bulletins Nos. 21 and 69 of the Bureau of Plant Industry reference is made to the increasing number of vegetable varieties and to the need of some established standard of excellence for vegetable types. The present publication, which is a continuation of the line of work followed in the bulletins mentioned, is largely the outgrowth of variety tests carried on at Washington, D. C., and in various places in the States of Connecticut, New York, Minnesota, Nebraska, Missouri, California, and Washington. Considerable assistance was obtained by Mr. Tracy from the publications of the State agricultural experiment stations, and many valuable suggestions were offered by seedsmen and seed growers, several of whom have reviewed the manuscript of this monograph.

Varieties of garden vegetables are now in such a confused condition and reports of vegetable trials generally are so meager and contradictory that it is usually quite impossible for any but the experienced seedsman to determine whether a vegetable type, unknown to a particular community, is really a new type or a sort already cultivated in some part of the country. Many varieties are probably unintentionally renamed, and much unnecessary experimentation and comparison are carried on every year with sorts which are thought to be distinct, but are really identical.

It is hoped that the illustrations and descriptions included in this bulletin will prove adequate to serve as a standard for the different bean varieties and that the notes on the practical value and usefulness of the different sorts, although not yet sufficient to make that part of the bulletin authoritative, will at least be full enough to make a beginning toward establishing the horicultural status of our bean varieties.

Respectfully,

B. T. Galloway,
Chief of Bureau.

Hon. James Wilson,
Secretary of Agriculture.

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AMERICAN VARIETIES OF GARDEN BEANS.

INTRODUCTION.

Next to the potato, the bean is by far the most important vegetable of this country. Being sold in the United States under more than 400 varietal names and having at least 185 distinct types, it easily stands first among vegetables in the number of varieties, and being grown extensively as a field and garden crop, it easily ranks second in the value of crops produced. Dry beans are a staple farm product in many sections of the United States, and snap and green shell beans one of the important green vegetables during the summer months. One American seedsman sells every year more than 24,000 bushels of seed of garden varieties alone.

BOTANICAL RELATIONSHIP OF BEAN SPECIES.

Those plants which are commonly classed as beans include a great number of different species and genera of the Leguminosæ family, the same family to which the garden pea, the sweet pea, the clovers, and the vetches belong. Of these many species this bulletin deals only with garden beans[a] or with those species cultivated chiefly as food for man rather than for fodder, for soiling crops, or for ornamental planting.

GARDEN SPECIES.

The five species whose varieties are described in this bulletin are as follows:

Phaseolus vulgaris, the Kidney bean, one of the hundred or more species of the genus Phaseolus, is the most varied in type and the most widely scattered of all the bean species. The total number of distinct varieties throughout the world is probably at least 500.

Phaseolus lunatus, the Lima bean, is also quite numerous in variety types, but the total number grown to any extent throughout the world is probably less than 50.

[a] See Farmers' Bulletin No. 289, "Beans."

Phaseolus coccineus (*P. multiflorus*), known as the Runner bean in Europe and as the Multiflora or Scarlet Runner bean in America, is represented throughout the world by perhaps 50 or more distinct varieties.

Vigna sesquipedalis (*Dolichos sesquipedalis*), the Asparagus bean, one of 30 or more species of the genus Vigna, is a comparatively unimportant and unknown plant in agriculture and is represented throughout the world by possibly a dozen distinct varieties.

Vicia faba, the Broad bean, one of the 100 or more species of the genus Vicia, is represented throughout the world by several hundred distinct varieties. To the same genus also belong *Vicia sativa*, commonly known as spring vetch or tare, and *Vicia villosa*, commonly known as hairy or winter vetch.

FIELD SPECIES.

Species not described in this bulletin and which are more important as farm crops than as garden vegetables include in America the following types:

Vigna sinensis, the cowpea,[a] one of 30 or more species of the genus Vigna, very closely resembles *Vigna sesquipedalis*, mentioned as a garden variety. It is represented by a great number of distinct types, though only a few have yet found their way into print, the total number of distinct varieties probably aggregating at least 50. This species is chiefly used in this country as a forage and soiling crop.

Glycine hispida, the soy bean,[b] one of 15 to 20 species of the genus Glycine, is represented by possibly 40 distinct varieties. This species is used in this country almost entirely as a soiling and forage crop, but it is largely cultivated in Japan and other oriental countries as food for man.

Mucuna pruriens var. *utilis*, the Velvet bean, one of 20 to 30 species of the genus Mucuna, is represented by several distinct varieties and is useful in the South as a soiling and forage crop.

Canavalia ensiformis, the Jack bean, one of 17 or more species of the genus Canavalia, is an unimportant plant in agriculture, being used only to a small extent in the South as a forage and soiling crop. There seem to be no well-defined varieties of this species in cultivation.

Dolichos lablab, the Hyacinth bean, one of 40 to 50 species of the genus Dolichos, is represented by perhaps 6 or more varieties, all of

[a] See Farmers' Bulletins No. 89, "Cowpeas," and No. 278, "Leguminous Crops for Green Manuring;" also Bulletin No. 17 of the Bureau of Plant Industry, "Some Diseases of the Cowpea."

[b] See Bulletin No. 98 of the Bureau of Plant Industry, "Soy Bean Varieties."

which are used as ornamental climbers. The species is of little practical value except for the fact that the seeds are used to a small extent in the Tropics as food for man.

PRINCIPLES OF CLASSIFICATION.

Garden beans naturally divide themselves primarily into the five species of which American bean varieties consist. So far there have been no hybrids between the different species of garden beans, and all garden varieties belong unquestionably to one or the other of these five species. Two of these, the *Vicia faba*, or English Broad bean, represented in this country by about 10 distinct varieties, and the *Vigna sesquipedalis*, or Asparagus bean, represented in this country by one distinct variety, contain so few contrasting types that they are not separated into classes, but the remaining 3 species are very readily classified.

Phaseolus vulgaris, the Kidney bean, represented in this country by 145 distinct varieties, has often been separated by botanists and horticulturists, principally on the color and shape of the seed. The objection to such a classification or to any classification based chiefly or wholly on a single character is that it often separates varieties which are very similar or identical in other respects and brings together sorts which are very different in habit of vine or other qualities. The best classification for Kidney beans seems to be as follows: (1) Into pole and bush, (2) into green-podded and wax-podded, (3) into different degrees of brittleness or toughness of pods, and (4) into various other divisions and subdivisions, based upon habit of vine, shape of pod, color of seed, or on some other quality peculiar to each subdivision, these final distinctions depending, as pointed out in the classification on page 29, upon the quality which best brings together identical or similar varieties. Such a classification separates most of the field from the garden varieties, most of the horticultural class from those not known as horticultural, most of the Red Valentine class from other varieties, and makes various other characteristic and useful divisions.

Phaseolus lunatus, the Lima bean, is also separated primarily into pole and bush. In this species the shape of the seed is so very characteristic that both the pole and bush varieties may be divided upon this character as follows: (1) Into flat, large-seeded sorts typifying large, wide, somewhat flat pods with large but not glossy leaf; (2) into flat, small-seeded sorts typifying small, very flat pods with small, glossy leaf; and (3) into thick, large-seeded sorts typifying thick-seeded rather than large, flat-seeded sorts, and large dull rather than small glossy leaves. Other than these divisions, there is no further classification of Limas which has any significance among American sorts.

Phaseolus multiflorus, the Multiflora bean, is represented in this country by but 4 varieties, the only characteristic class distinction between them being the pole and bush forms.

HISTORY OF VARIETIES.

Botanists now agree that *Phaseolus vulgaris*, *P. coccineus* (*P. multiflorus*), and *P. lunatus* are natives of America. It is equally certain that *Vicia faba* and *Vigna sesquipedalis* (*Dolichos sesquipedalis*) are of Old World origin. For a long time it was not definitely known whether the different species were of Old or New World origin, but the discovery of seeds in certain tombs and with mummies and on old records has now made their origin more certain. It is not yet positively known, however, in what particular region the different species are native nor just where they were first cultivated by man. Broad beans were undoubtedly grown by the ancient Egyptians, and kidney beans of many varieties were certainly used by the American Indians at the time of the discovery of America. Lima and Multiflora beans are also known to have been cultivated in the New World for many centuries and the Asparagus beans to have been used in China for a very long time. Kidney beans were probably first carried over to Europe from America about the middle of the sixteenth century, but did not come into general use on the Continent until near the end of the century, while the Multiflora beans were not disseminated till a later period.

Of the 185 distinct varieties of beans now cultivated in this country, only 15 were grown eighty years ago, or, if there were more, they must have been known by quite different names from those they are known by to-day. It is interesting to note that prior to 1815 American seedsmen listed more varieties of Broad beans than at present. The early settlers were apparently so accustomed to Broad beans in Europe that they first endeavored to grow them here, and it was only after it was discovered that the climate of the New England and Middle Atlantic States is unsuited to these beans that their general advertisement was discontinued. In 1822 Thorburn listed 6 varieties of Broad beans, 8 of bush Kidney, 3 of pole Kidney, 1 of pole Lima, and 2 of the Multiflora.

Previous to 1880 nearly all new types of garden beans came from Europe, but since that time nearly all have had their origin in this country. The first wax variety grown in America appears to have been Black Wax Pole, which has been in use at least since 1860, while Black Wax Bush, introduced from Germany about 1865, was probably the first wax bush variety. When introduced these beans were probably not the stringless type that they are to-day, and owing to changes which variety types have undergone it seems

impossible to say when the first stringless variety appeared; it certainly must have been later than 1860. The highest standard of quality in snap pods was reached in 1889 with Yosemite Wax. Many varieties of excellent quality have been introduced since that date and some old varieties improved, which are practically equal to but do not surpass the Yosemite in quality.

All the Lima varieties grown in this country have had their origin in America. The first bush form of these beans was listed in 1889. Only during the last twenty-five years has the greatest improvement been made by American seedsmen and seed growers in bean varieties, but as all these improvements and other historical matters are mentioned in the varietal descriptions it is not necessary to make further reference to them here.

RULES FOR DESCRIPTION.

To simplify varietal nomenclature and avoid confusion in variety descriptions, it is necessary to adopt the following rules for the use of names and description of types.

Type names.—After a varietal type is described, it is next necessary to decide which of the many names applied by seedsmen to the type shall be selected as the one by which the type shall be known. Generally the name first used should be adopted, but as the original name sometimes goes out of general use or even disappears altogether from the trade this rule is not always practicable. Even though possible to determine which name was first used, there yet remains the doubt as to whether the old name represents at the present time the same type as when first used. Another type may have been adopted, as, for example, an improved strain may have appeared in the old type, and this may have been given a new name and called a new variety. In course of time seedsmen, in receiving orders for the old variety, may think it best to fill such orders with seed of the improved strain instead of with that of the old type, which they may have discarded altogether. This is what seems to have occurred with Horticultural Bush, so that instead of sending out the old type nearly all seedsmen now send out Ruby Horticultural Bush, which was developed from Horticultural Bush.

Confusing names.—Some names are undesirable because so similar to others as to be easily confused with them; others because so many worded as to be bewildering and inconvenient. In regard to the latter point, it is generally safe to drop from variety names all such words as improved, selected, perfected, extra, select, choice, superior, celebrated, fine, true, and most words in the possessive case.

Source of seed.—As different seedsmen sometimes recognize quite different types for the same variety, it becomes important that the

names of seedsmen be given upon whose samples variety descriptions are based. It does not seem worth while, however, to publish occasional or temporary errors which occur in supplying seed orders. Mistakes in variety types are sometimes unavoidable, and the reliability of different seed houses is ascertainable only by a large number of tests, much larger, in fact, than it is usually profitable to make. The question of locality for bean varieties has not yet become important in the United States. This is largely because most of the seed at present is obtained from a few well-recognized localities, and also because it is not yet certainly known whether beans coming from particular localities are really superior to those from other localities. No mention is therefore made in the following descriptions as to where the seed samples were grown. Most of the Kidney bush sorts, however, were probably grown either in New York, Michigan, or Wisconsin, and most of the pole and Lima varieties in California.

Variety forms.—In comparing vegetable varieties a regular order of description should be followed. Some kind of variety form is necessary to avoid omission of the qualities on which information is desired, as well as to make reports orderly, precise, and comparable with those of other experimenters.

VARIETY FORMS FOR BUSH KIDNEY BEANS.

The characters referred to in the variety descriptions of this bulletin are explained here in the same order in which they are followed in the descriptions of the variety types. In addition to these general characters, there are some others peculiar to one or several varieties which are not mentioned, but are discussed in the descriptions of the varieties possessing them. Following each character are generally given the terms used to express its variation. Where no such degrees are noted there is either no great variation in the character or else the varieties are too numerous and irregular to admit of a concise expression of the same.

Size of plant (very large, large, large-medium, medium, small-medium, small, very small).—Size of plant is largely indicative of season and productiveness, and ranges from varieties so large that, like the California field sorts, they require a distance of 32 inches or more between rows to varieties so small that, like the small garden varieties, they require but half the distance of the field sorts, and even then do not fill the rows as completely. The variations for strictly garden beans range from Hodson Wax, for the large sorts, to Taylor's Green Pod, for the very small kinds.

Habit of plant (very erect, erect, somewhat spreading, spreading, very spreading).—Erectness refers to the tendency of plants to grow upright, stiff, and rigid, instead of drooping, spreading, and develop-

ing many runners. It is a habit which is not always the same at all stages of growth, some varieties, like Burpee's Stringless Green Pod, being very erect when young, but burdened with fruit-laden branches and drooping when old. For this reason it is necessary to select one stage of a plant's growth at which to describe this peculiarity. The most typical stage and the one adopted in the following descriptions is the time just before the plant comes into full bearing. Variations in habit range from Red Valentine for very erect sorts to Navy Pea and other field varieties for very spreading kinds.

Thickness of plant stems (very slender-stemmed, slender-stemmed, somewhat slender-stemmed, somewhat thick-stemmed, thick-stemmed, very thick-stemmed).—This character is generally correlated with appearance, size, and shape of the leaves, those plants having large, coarse, and wide leaves, like Canadian Wonder and Burpee's White Wax, generally being thick-stemmed, and those plants having small, smooth, narrow leaves, like Refugee and Red Valentine, generally being slender-stemmed.

Number of runners (without runners, occasional runners, moderate number of runners, many runners, etc.).—Some varieties, besides having runners as described above, often develop drooping branches and long fruit spurs, which, though generally not to be classed as runners, sometimes develop into real runners, as is shown by Tennessee Green Pod and Emperor William. Late Refugee and Navy Pea are examples of decidedly spreading bush sorts, and Golden Wax and Round Yellow Six Weeks of varieties absolutely free from runners.

Color of plant stems and branches.—Except Blue Pod Butter, Black Turtle Soup, Lightning, and some varieties having black seed, all beans cultivated in America are green throughout the plant. As explained below, the solid dark-leaved sorts are separated into various shades of green, but their stems and branches are referred to by no other term than green. Only the first two of the above-named varities are colored to any extent, and, while the above black-seeded sorts are commonly classed as green-stemmed, they will be found, upon close examination, to be slightly tinged on the main stem, at nodes of branches, and on the flower stalks.

Season of bush varieties (very early, or less than 46 days; early, 46 to 48 days; early-intermediate, or 49 to 51 days; intermediate, or 52 to 54 days; intermediate-late, or 55 to 57 days; late, or 58 to 60 days; very late, or more than 60 days).—In the above estimates, as well as in the variety descriptions, earliness unless otherwise noted is based upon the time when snap pods are first usable and not when seeds are first dry and ready for thrashing. Although strictly green shell and field sorts are seldom used as snaps, it nevertheless seems

desirable to always give the season of the snap pod stage so as to have at least one period at which all varieties are compared, while the season of the other periods need be given only in varieties where green shell and dry beans are more important than snap pods. Some field sorts which produce snap pods much later than some garden varieties would, if judged upon a snap-pod basis alone, be classed as late, when in reality they ripen their crops of seeds much earlier than some so-called early garden varieties. The reason for some garden varieties being early as snaps but late as dry beans is explained by the large amount of flesh or pulp in many round-podded garden sorts, which requires for such pods a long time to dry, whereas the pods of field varieties, consisting, as they do, of thin, tough walls, ripen very quickly when once the pods start to dry. The season of green shell beans is not stated in the descriptions, but can be easily ascertained by adding 8 to 10 days to the snap-pod stage, and for field varieties and flat-podded garden sorts, such as Lightning and Tennessee Green Pod, from 6 to 8 days to the same period.

Length of bearing period (very short, short, moderate, long to moderate, long, very long).—This quality is closely related to season, the early varieties generally being shorter lived than the late sorts and without continuous-growing fruit-bearing runners and branches. The harvesting of an entire crop at a few pickings is sometimes desired by market gardeners, but for home and general use a longer period of available snap and green-shell pods is more desirable.

Productiveness (very light, light, light to moderate, moderate, heavy to moderate, heavy, very heavy).—This character is closely correlated with season, size, and vigor, the earlier, smaller, and less vigorous varieties of the extremely early garden class generally being less productive than the late, large, coarse-growing kinds. An average yield of dry seed for very light croppers, such as Valentine Wax, is 8 bushels, and for very heavy croppers, such as Late Refugee, 14 bushels to the acre. The former has been known, however, to produce as high as 18, and the latter as high as 40 bushels to the acre. The yield of field varieties is considerably more than that of the garden sorts, claims of 60 bushels being sometimes made, though the average for the whole country is only about 12 bushels to the acre.

Size of leaves (very large, large, medium, small, very small).—As the size of the leaves in the bean plants depends so largely upon the position of the leaves on the plant, and as there is but little difference between varieties in the average size of leaves, this quality is generally of little aid in identification. There are, however, a few thick-stemmed sorts, like Giant Forcer, which have very uniformly large leaves, and a few slender-stemmed running sorts, like Crystal Wax, which have very uniformly small leaves.

Color of leaves (very dark green, dark green, medium green, light green, very light green, grayish green, etc.).— Except Blue Pod Butter and Black Turtle Soup, all bush varieties cultivated in the United States have solid green leaves, the depth of color varying from very dark green, as in Triumph of Frames and other green-seeded sorts, to very light green, as in Bountiful. Some varieties, like Late Refugee and the California field sorts, are peculiar on account of a distinct grayish green color.

Shape of leaves (narrow across leaflets, medium in width across leaflets, wide across leaflets).—Most bean varieties are so similar in the shape of their leaves that this character is referred to in the following descriptions only when the shape is unusual, as in Red Valentine and Refugee Wax, which have narrow, pointed leaflets, and in Blue Pod Butter and Black Turtle Soup, which have extremely broad leaflets. Some varieties are peculiar for being widest across the base of the leaflets; others, in being widest across the middle portion.

Surface of leaves (very smooth, smooth, somewhat rough, rough, very rough).—Most bean varieties are generally so alike in leaf surface, and this character changes so much from very smooth in well-grown plants to very rough in poorly grown ones, that the smoothness and roughness of leaves is not often of assistance in identification. In the following descriptions, therefore, it is referred to only in exceptional cases, such as in Best of All, which has very uniformly rough leaves, and in Crystal Wax and Rogers's Lima Wax, which have very uniformly smooth leaves.

Length of petiole (short, medium, long).—The length of the stem of bean leaves depends largely upon the location of the leaves on the plants and is usually of but little aid in identification. Varieties like Hodson Wax, with narrow leaflets, generally have very long petioles, while those with broad leaflets, like Best of All, generally have short ones.

Color of blossoms (pink, light pink, very light pink, shell pink, etc.).— Except Blue Pod Butter and Lightning, all bush varieties cultivated in this country bear flowers which are either white or some shade of pink. The flowers of some varieties change or wilt to light primrose when old, but are white in color when young and are so classed in the descriptions.

Uniformity in size of snap pods (very uniform, uniform, somewhat variable, variable, very variable).—Most varieties are quite uniform in the size of their pods, but sometimes, even on the same plant, the size of pods is quite variable. This is especially true with varieties like Boston Favorite which have been neglected in selection.

Length of snap pods (very short, short, short medium, medium, long, medium long, very long).—Snap pods range in length from 7½ inches, as in Canadian Wonder, to 3½ inches, as in Snowflake.

Straightness of snap pods (very straight, straight, moderately straight, moderately curved, much curved).—Some stringy pods, like Long Yellow Six Weeks, curve at the middle only; some stringless ones, like Round Pod Kidney Wax, are scimiter curved; other stringless pods, like Grenell's Stringless Green Pod, curve at their extreme tip end only; some, both of the stringless and stringy types, like Wardwell's Kidney Wax and Day's Leafless Medium, curve backward at the extreme stem end only; and some others, like Navy Pea, Longfellow, and Improved Goddard, are straight from end to end. In making comparisons of these peculiarities, it should be remembered that poorly grown pods are generally more curved than well-grown ones.

Cross sections of snap pods (very flat, flat, oval flat, oval, oval round, round, round broad, very broad, or double barreled).—Varieties described as round or fleshy are generally the most tender, while those described as flat are usually most full of fiber and even when without string and tough parchment, as in Warren Bush, are at least harder in texture and require longer to cook than those composed more largely of soft fleshy pulp. Some sorts, like Snowflake, are flat at the snap stage, but become almost round at the green shell period, while others, like Refugee, change but little. Some varieties, like Emperor William, are decidedly too flat to be attractive as snaps, while others, like Yosemite, are so broad as to resemble two pods grown together.

Color of snap pods (very dark green, dark green, medium green, light green, very light green, light yellow, medium yellow, deep yellow, etc.).—Many varieties are brilliantly splashed at the green-shell stage, but nearly all varieties listed by American seedsmen are either solid green or solid yellow at the snap pod stage, the only exceptions being Blue Pod Butter, Black Turtle Soup, and a few, like Refugee Wax, which are faint red or purplish splashed at the snap pod stage, and some black-seeded varieties which are reddish streaked along the sutures and at the stem end. Golden Refugee and Crystal Wax, which are silvery green in color, are classed by some as green-podded and by others as wax-podded.

Brittleness of snap pods (very brittle, brittle, somewhat brittle, somewhat tough, tough, very tough).—Some varieties, like Pencil Pod Black Wax, are so brittle that they break when bent very little, while others, like Davis Wax, must be cut and can not be readily broken unless gathered when very young and undersized.

Stringiness of snap pods (stringless, inappreciably stringy, slightly stringy, of moderate string, of strong string, or very strong string).—String in bean pods is used to designate the strip of inedible tough fiber at the dorsal and ventral sutures of many pods. Its presence usually indicates toughness and poor quality, but not always, as is

well shown by Red Valentine, which, although stringy, is one of the tenderest and most fleshy of all varieties.

Fiber in snap pods (none, inappreciable, small, moderate, much).—Fiber in bean pods is used to designate the tough layer of parchment present to a greater or less degree in the walls of all pods at the green-shell stage, but absent or inappreciable at the snap-pod stage of some varieties.

Quality of snap pods (very good, good, good to medium, medium, poor to medium, poor, very poor).—Quality in snap pods of American kidney beans is largely a question of tenderness, fleshiness, and freedom from fiber and, unlike English Broad beans and other species, hardly at all a matter of flavor. Contrary to general opinion, as good a quality of snap pods can be selected from the green-podded as from the wax-podded varieties.

Freedom from anthracnose, rust, and other diseases.—Resistance to disease depends so largely upon conditions that only by a very large number of tests can an exact statement on disease resistance be obtained. In some favorable seasons all the varieties in the tests of the Department of Agriculture were free from disease; in other years nearly all were more or less affected; while in still other years sometimes the early and sometimes only the late sorts were affected. In some seasons the conditions favoring the spread of disease do not come till the early sorts are past injury; in other years these injurious conditions may exist only during the period of the early varieties. It seems also that diseases may be carried in the seed and that the presence of anthracnose and rust are due merely to accidental or temporary infection of particular lots of seed rather than to a continuous or inherent tendency of certain varieties to disease. As the results of tests of disease resistance made by the Department of Agriculture were somewhat irregular and incomplete, the notes made in this bulletin on freedom of varieties from anthracnose can not be said to apply regularly to all sections of the country.

Dorsal and ventral sutures.—These are terms used in botany to denote the lines of dehiscence in seed pods, the ventral suture signifying the line along which the seeds of a pod are attached and the dorsal suture the opposite line of dehiscence. Morphologically speaking, a seed pod consists of one or more transformed folded leaves, that of the bean pod being analogous to a single leaf the margins of which have folded inward and grown together so as to produce seeds at their line of union.

Length of pod point (very long, long, medium, short medium, short, very short).—The pod point or spur of bean pods varies in length from very long, as in Longfellow and Bountiful, to very short, as in Eureka and Wardwell's Kidney Wax.

Straightness of pod point (straight, slightly curved, moderately curved, much curved, twisted, etc.).—The shape of pod points is often an indication of stringiness. Pod points which are twisted, irregularly curved, blunt at the end, or depressed at their juncture with the pod indicate very little or no string, while pod points which are regularly tapering and stiff indicate a more or less strong string.

Size of pod clusters.—Under uniformly favorable conditions the size of pod clusters is a helpful and reliable aid to the identification of varieties; but, as the Department trials have not usually been perfect enough to develop this character, no reference is generally made to it in the following descriptions. Barteldes's Bush Lima, Tennessee Green Pod, Wonder of France, and Burpee's Stringless Green Pod are examples of varieties bearing a large number of pods to the cluster.

Position of pod clusters (well below foliage, mostly below foliage, equally above and below foliage, mostly above foliage, well above foliage).—Quite a number of European sorts, as well as a few domestic kinds, such as Lightning, have numerous, thick, strong-stemmed clusters, bearing nearly all their pods well above the plant; other varieties, mostly of the slender, running type, like Refugee, bear nearly all their pods well under the foliage.

Color of green shell pods.—Most green-colored pods gradually lose their original green color and become almost as faded and yellow at the green-shell stage as are the wax sorts at this stage. For this reason the color of pods at the green-shell stage is not useful in identifying and describing varieties unless splashing or tingeing appears or some change occurs other than the usual fading of the pod. This splashing or tingeing, whenever it does appear, is generally some shade of purple or red and usually indicates splashed or colored seed.

Depressions between seeds (much depressed, moderately depressed, slightly depressed, full).—Tennessee Green Pod and most other varieties with seeds very much separated in the pod have their pod walls much depressed or sunken between the seeds; others, like Yosemite Wax and Stringless Green Pod, are so sharply constricted between the seeds that their pods appear as though they had been drawn tight by a thread and separated into sections; while still other varieties, like Refugee and certain round-podded sorts, are full or only slightly depressed between the seeds.

Length in inches of green shell pods.—The measurements given in the following descriptions are those of average-sized pods from well-grown plants. Exceptionally large pods may be one-third longer than the lengths named and unusually poor pods but two-thirds of these lengths.

Number of seeds in green shell pods.—Six is the usual number of seeds for most varieties and conditions, ten being the largest ever found in pods of bush beans at Washington, D. C. If plants be well

grown no American variety of Kidney bean contains less than four seeds.

Position of seeds in green shell pods (very crowded, crowded, fairly close, somewhat separated, fairly separated, much separated).—The position of seeds in a bean pod varies from the tightly crowded condition of Red Valentine to the much separated condition of Rogers's Lima Wax and Tennessee Green Pod.

Ease of thrashing dry pods (very easily thrashed, fairly easy to thrash, somewhat hard to thrash, hard to thrash).—Ease of thrashing is largely determined by the amount of fiber in bean pods. Thin-walled, tough-podded field varieties seldom wrinkle or shrivel tightly about the seed or break up into sections when thrashed, as do many of the fleshy-podded garden varieties.

Size of dry seeds (very small, small, small-medium, medium, large-medium, large, very large).—Of kidney beans the small-seeded varieties, like Navy Pea, produce about 2,200 seeds to the pint, the medium-seeded varieties, like Golden Wax, about 1,100, and the large-seeded varieties, like Improved Goddard, about 550. Bush Multiflora, Scarlet Runner, and White Dutch Runner produce about 250, Henderson's Bush Lima about 1,100, Burpee's Bush Lima about 320, and Dreer's Bush Lima about 450 seeds to the pint. Although the size of the seed is generally quite uniform in the same variety and varies but little from the illustrations given in this bulletin, they are nevertheless often affected by unusual seasons, locations, and soil conditions, those grown in very poor soil and during dry seasons often being but half the size of those grown in unusually damp locations and seasons.

Length of dry seeds (extremely slender, slender, medium, somewhat short, short, very short).—The shape of dry seed is a fairly constant feature which varies but little with season and conditions. Some kidney sorts, like Ruby Horticultural Bush, are almost as broad as long, while others, like Longfellow, are several times greater in length than in cross section.

Cross sections of dry seeds (very flat, flat, flat-oval, oval, round-oval, round).—The shape of the cross section of seeds is a fairly constant varietal feature and is usually an indication of the shape of the pods.

Ends of dry seeds (very rounded, rounded, rounded to truncate, truncate, decidedly truncate).—The shape of the ends of seeds depends largely upon the position of the seeds in the pod, those which are very crowded in the pod being generally square at the ends, while those which are well separated in the pod are usually rounded at the ends.

Curvature at eye of dry seed (much incurved, incurved, almost straight, straight, rounded or full, very well rounded or full).—Seeds vary in shape at the eye from the very incurved condition of French Flageolet to the very rounded or full condition of White Marrow.

Color of dry seeds.—Because different varieties of beans vary more in the color of seeds than is the case with other vegetables, there is less opportunity for substitution with bean varieties than there is with varieties of other vegetables. In exceptional soils and seasons, the amount of splashing and mottling may vary more or less from that shown in the plates of this bulletin. Golden Wax, for example, may in certain soil and seasons show very little white color, while under other conditions four-fifths of the surface of the seeds may be white. As no complete chart of colors is at present published in this country, it has been necessary to adopt as the standard for the description of colors the French publication edited by Henri Dauthenay and known as Repertoire de Couleurs.

VARIETY FORMS FOR POLE KIDNEY BEANS.

Pole Kidney beans are described in nearly the same terms as bush Kidney beans, the exceptions being as follows:

Climbing habit (good, fair, poor).—Pole beans, instead of being described as erect in habit, are classified according to their ability to take hold of and twine about poles or other supports. Some varieties, such as Golden Champion and many of the Horticultural class, at first appear to be spreading bush sorts and do not at once take readily to climbing, but when once started nearly all American varieties climb readily to poles or to any other suitable supports.

Branching habit (much branched, moderately branched, little branched).—This character, which is not included in the description of bush varieties, is of some use in defining pole sorts to express an open slender growth, like Kentucky Wonder, or dense spreading growth, like Virginia Cornfield.

Season of snap pods for pole varieties (very early, or less than 57 days; early, or 57 to 60 days; early-intermediate, or 61 to 64 days; intermediate, or 65 to 68 days; intermediate-late, or 69 to 72 days; late, or 73 to 76 days; very late, or more than 76 days).—Sometimes very early varieties, like White Creaseback and Golden Champion, produce pods before the runners appear; and when plants are checked in growth, especially those of the Horticultural class, they often show the same tendency. Six to ten days are required for different varieties of pole beans to develop from the snap into the green shell stage.

VARIETY FORMS FOR LIMA BEANS.

Most of the terms used to describe pole Kidney and bush Kidney varieties are also applicable to pole Lima and bush Lima varieties, respectively. The exceptions are that season in Limas is judged at the green-shell stage, and since Lima pods are neither usable nor characteristic at the snap-pod stage no description is necessary of them at that period, while color is described by merely stating the shade of green in leaf and pod.

Season of bush Lima varieties (very early, or less than 75 days; early, or 75 to 78 days; intermediate, or 79 to 81 days; late, or 82 to 84 days; very late, or over 84 days).—Both pole and bush Lima varieties seem more subject to delay in season through cold, wet weather and other unfavorable conditions than Kidney beans. Reports on season in Limas therefore differ greatly, and though the above-mentioned periods are applicable to most conditions, they nevertheless vary from one to three weeks longer and sometimes from a week to 10 days shorter than stated here.

Season of pole Lima varieties (very early, or less than 80 days; early, or 80 to 83 days; intermediate, or 84 to 86 days; late, or 87 to 89 days; very late, or over 90 days).—As previously stated, this quality is subject to great variation in Limas. In pole varieties an additional source of variation arises from certain stray pods which ripen early but are too few in number and too spasmodic in season to be a real indication of earliness.

SUMMARY OF DESIRABLE VARIETIES.

The following lists represent a cursory review of some of the important decisions stated in the variety descriptions of this bulletin. Such lists as these are, of course, subject to many limitations, as all experienced gardeners will appreciate. Many varieties not suited for general use, but admirably adapted to special soils, markets, and conditions, are not included in these lists, and others just as suitable as the sorts named but differing from them in immaterial respects are also omitted. Standard varieties and sorts representing considerable range in type have generally been selected, the object being to avoid as far as possible those sorts which are but little known and also those which represent very similar characteristics.

Desirable bush varieties for home use.—For green-colored snaps: Giant Stringless Green Pod, Red Valentine, Late Refugee, Warren Bush. For yellow-colored snaps: Maule's Nameless Wax of 1906,

Pencil Pod Black Wax, Keeney's Rustless Golden Wax, Refugee Wax, Burpee's Kidney Wax. For combination of snaps and green shell in a single variety: Ruby Horticultural Bush, Warren Bush. For Lima beans: Wonder Bush, Dreer's Bush, Wood's Prolific Bush. For Kidney green shell beans: Improved Goddard, Ruby Horticultural Bush, Tennessee Green Pod.

Profitable bush varieties for market.—For green-colored snaps: Hodson Green Pod, Late Refugee, Black Valentine, Extra Early Refugee, Giant Stringless Green Pod, Red Valentine. For yellow-colored snaps: Hodson Wax, Keeney's Rustless Golden Wax, Golden Wax, Davis Wax, Refugee Wax, Bismarck Black Wax. For Lima beans: Wonder Bush, Wood's Prolific Bush, Dreer's Bush. For Kidney green shell beans: Improved Goddard, Ruby Horticultural Bush. The above sorts were selected without reference to whether the quality is good or bad, the most importance being given to productiveness, attractiveness, hardiness, and shipping qualities.

Desirable pole varieties for home use.—For green-colored snaps: Black Kentucky Wonder, Burger's Stringless, Kentucky Wonder, Lazy Wife Pole. For yellow-colored snaps: Golden Carmine-Podded Horticultural, Golden Cluster Wax, Indian Chief. For combination of snaps and green shell beans in a single variety: Lazy Wife, Black Kentucky Wonder, Golden Carmine-Podded Horticultural. For Lima beans: Henderson's Ideal, Wood's Improved Pole Lima, Dreer's Pole Lima. For Kidney green shell beans: Lazy Wife, Childs's Horticultural, London Horticultural, Golden Carmine-Podded Horticultural.

Profitable pole varieties for market.—For green-colored snaps: White Creaseback, Black Kentucky Wonder, Lazy Wife, Scotia. For yellow-colored snaps: Indian Chief, Kentucky Wonder Wax, Golden Carmine-Podded Horticultural. For Lima beans: Henderson's Ideal, Wood's Improved Pole Lima, Dreer's Pole Lima, Leviathan. For Kidney green shell beans: London Horticultural, Childs's Horticultural, Worcester Mammoth, Dutch Case Knife.

Most largely grown garden bush varieties.—Of green-colored Kidney sorts Red Valentine is by far the most largely planted, followed next by Late Refugee, Burpee's Stringless Green Pod, Giant Stringless Green Pod, Extra Early Refugee, and Mohawk. None of the wax sorts are as extensively planted as the more popular green-podded sorts. The most largely grown of the class are Improved Golden Wax, Golden Wax, Wardwell's Kidney Wax, German Black Wax, Davis Wax, and Currie's Rustproof Wax. The most popular Lima varieties are Burpee's Bush Lima, Henderson's Bush Lima, and Dreer's Bush Lima.

Most largely grown field varieties.—Navy Pea, commonly known to the produce trade as Marrow Pea, is by far the most popular

variety; following it are the Mediums, represented by Burlingame Medium, Day's Leafless Medium, and others of local or trade names. White Marrow and Red Kidney probably rank third and fourth.

Most largely grown garden pole varieties.—Of the green-colored kidney sorts Kentucky Wonder is by far the most largely grown. After it come London Horticultural, Lazy Wife, White Creaseback, and Dutch Case Knife. None of the wax sorts are planted as extensively as the more popular green-colored sorts. The most largely grown of the class are probably Indian Chief and Golden Cluster Wax. The most largely grown Limas are King of Garden Pole, Large White Pole, and Small White Pole.

Most productive garden bush varieties.—For green-colored snaps: Hodson Green Pod, Galega, Golden Refugee, Late Refugee, Byer's Bush. For yellow-colored snaps: Hodson Wax, Refugee Wax, Keeney's Rustless Golden Wax, Speckled Wax. For Lima beans: Wonder Bush, Dreer's Bush, Wood's Prolific Bush, or Burpee's Bush, depending upon conditions. For Kidney green shell beans: Improved Goddard, Boston Favorite, Warren Bush, Marblehead Horticultural, White Kidney.

Most productive pole varieties.—For green-colored snaps: Powell's Prolific, Scotia, Black Kentucky Wonder, Lazy Wife, London Horticultural. For yellow-colored snaps: Indian Chief, Andulusia Wax, Golden Cluster Wax. For Lima beans: King of Garden, Dreer's Pole, or Wood's Improved Pole, depending greatly upon conditions. For Kidney green shell beans: London Horticultural, Lazy Wife, Dutch Case Knife.

Bush varieties of good quality.—For green-colored snaps: Burpee's Stringless Green Pod, Giant Stringless Green Pod, Knickerbocker, Henderson's Full Measure, Red Valentine, Warren Bush. For yellow-colored snaps: Yosemite Wax, Pencil Pod Black Wax, German Black Wax, Refugee Stringless Wax, Maule's Nameless Wax of 1906. There is so little difference in quality between Kidney varieties at the green and dry shell stages and tastes vary so greatly as to what is good quality at these stages that it seems quite impossible to say which varieties are best in quality for green shell and baking beans. The horticultural varieties are, however, generally classed in America as the best for green shell beans. For baking beans certain varieties of the so-called field beans are preferred by different nationalities, as, for instance, persons of Spanish descent generally prefer the Red Kidney, the California field varieties, or other kinds to which they have been accustomed, while Americans usually prefer the Marrow or Pea varieties, and Swedish people the Brown Swedish varieties to which they are accustomed. Opinions differ greatly regarding the quality of Lima beans, but Dreer's Bush is generally given first place; Burpee's Bush,

or some other large, flat-seeded sort, second place, and Henderson's Bush, or some other small, flat-seeded sort, third place.

Pole varieties of good quality.—More than half the green-podded varieties and all the wax-podded pole sorts, except Golden Champion, are of good quality as snaps. Burger's Stringless probably stands first, after which comes Lazy Wife, then Arlington Cranberry, Golden Carmine-Podded Horticultural Wax, Golden Cluster Wax, and Kentucky Wonder Wax. The remarks already made on the quality of green and dry shell beans of bush varieties apply also to pole sorts.

Earliest and latest bush varieties for snaps.—For earliest green-colored snaps: Warwick, Bountiful, Taylor's Green Pod, Ne Plus Ultra, and Grenell's Stringless Green Pod. For earliest yellow-colored snaps: Challenge Black Wax, Valentine Wax, Golden Wax, Improved Golden Wax, Currie's Rustproof Wax. For latest green-colored snaps: Galega, Hodson Green Pod, Late Refugee, Golden Refugee, Byer's Bush. For latest yellow-colored snaps: Hodson Wax, Speckled Wax, Burpee's White Wax, Refugee Wax.

Earliest and latest pole varieties for snaps.—Earliest green-colored snaps: White Creaseback, Burger's Stringless, Kentucky Wonder, Arlington Red Cranberry. For earliest yellow-colored snaps: Golden Champion Pole, Kentucky Wonder Wax, Golden Carmine-Podded Horticultural. For latest green-colored snaps: Powell's Prolific, White Sickle, Scotia, London Horticultural. For latest yellow-colored snaps: Indian Chief, Mont d'Or, Andulusia Wax.

Disease-resistant varieties.—As already explained, disease resistance in bean varieties is subject to great variation. For this reason, advice on selection can be given along general lines only, the most important being that large, vigorous-growing, stringy, tough-podded, green-podded, and field varieties are generally less subject to disease than correspondingly small, frail-growing, stringless, brittle-podded, wax-podded, and garden varieties. Conspicuous exceptions occur in all these groups; for example, the tough-podded Davis Wax has of late years been more subject to rust and anthracnose than many tender-podded wax varieties, and the green-podded Longfellow more susceptible to disease than many tenderer podded sorts of less vigor.

Little-known but desirable varieties.—Green-podded bush: Hodson Green Pod, Byer's Bush, Warren Bush, Henderson's Full Measure, Golden Refugee. Wax-podded bush: Hodson Wax, Maule's Nameless Wax of 1906, Keeney's Rustless Golden Wax, Burpee's Kidney Wax, Bismarck Black Wax, Golden Crown. Bush Lima: Wonder Bush, Wood's Prolific Bush. Green-podded pole: Black Kentucky Wonder, Scotia, Burger's Stringless, Powell's Prolific, White's Prolific. Wax-podded pole: Golden Carmine-Podded Horticultural, Kentucky Wonder Wax. Pole Lima: Henderson's Ideal, Leviathan, Wood's Improved Pole.

CLASSIFICATION OF VARIETIES.

Vicia faba (English Broad beans). Leaves pinnate, the terminal leaflet wanting or represented by a rudimentary tendril; seeds with hilum extending over at least one-fifth circumference of seed; plants erect.....Broad Windsor.

Vigna sesquipedalis (Yard Long or Asparagus bean). Leaves pinnately trifoliate, the terminal leaflet present; seeds with hilum extending over less than one-tenth circumference of seed; flowers with keel not spirally twisted; plants climbing or trailing, never erect.....Yard Long.

Phaseolus coccineus (Multiflora beans). Leaves pinnately trifoliate, the terminal leaflet present; seed with veining almost imperceptible; flowers large, or at least 1¼ inches across wings, and with keel spirally twisted; roots tuberous-rooted or thickened.

Plants bush.....Aroostook Bush Lima, Bartledes's Bush Lima.

Plants pole.....Scarlet Runner, White Dutch Runner.

Phaseolus lunatus (Lima beans). Leaves pinnately trifoliate, the terminal leaflet present; seeds with more or less pronounced veining and flat to oval-flat; flowers small or not over ⅝ inch across wings; roots fibrous; pods not edible at any stage of development.

Plants bush.

Seeds flat and large.....Burpee's Bush Lima, Wonder Bush Lima.

Seeds flat and small.....Henderson's Bush Lima, Wood's Prolific Bush, Willow-Leaved Bush, Jackson Wonder Bush.

Seeds thick and large.....Dreer's Bush Lima.

Plants pole.

Seeds flat and large.....Leviathan Pole, Seibert's Pole, Extra Early Jersey Lima, Large White Lima, King of Garden, Henderson's Ideal, Ford's Mammoth, Salem Mammoth, Mottled Lima, Long-Podded Lima.

Seeds flat and small.....Small White Lima, Willow-Leaved, Wood's Improved, Florida Butter.

Seeds thick and large.....Dreer's Pole.

Phaseolus vulgaris (Kidney beans). Leaves pinnately trifoliate, the terminal leaflet present; seeds with more or less pronounced veining, mostly round but sometimes flat through cross section; flowers small or not ⅝ inch across wings; roots fibrous; pods edible, at least when young.

Plants bush.

Pods more or less green in color at snap stage.

Fully developed snap pod brittle, or at least readily breaking when bent.

Pods more or less flat.....Bountiful, Grenell's Stringless Green Pod, Ruby Horticultural, Yellow Cranberry, Warren Bush, Low's Champion.

Pods varying from oval to round in cross section.

Plants decidedly spreading or with semirunners.....Golden Refugee, Refugee, Yankee Winter.

Plants erect, or at least devoid of semirunners.

Pods stringless or nearly so.....Burpee's Stringless Green Pod, Giant Stringless Green Pod, Henderson's Full Measure, Knickerbocker, Garden Pride, Taylor's Green Pod, Round Yellow Six Weeks.

Phaseolus vulgaris (Kidney beans)—Continued.
Plants bush—Continued.
Pods more or less green in color at snap stage—Continued.
Fully developed snap pod brittle, etc.—Continued.
Pods varying from oval to round in cross section—Continued.
Plants erect, or at least devoid of semirunners—Continued.
Pods with more or less pronounced string.....Red Valentine, White Valentine, Cream Valentine, Extra Early Refugee, Byer's Bush, Longfellow, Best of All, Giant Forcer, Thorburn's Prolific Market.

Fully developed snap pods more or less tough or not readily breaking when bent, but sufficiently free from fiber to be in general use as snaps rather than as green or dry shell beans.
Plants very spreading or with semirunners.....Galega, Hodson Green Pod.
Plants erect or at least devoid of semirunners.
Plants purplish tinged and seeds light ecru.....Blue Pod Butter.
Plants green and seeds sea-green.....Triumph of Frames, Wonder of France.
Plants solid green and seeds black, brown, or other than sea-green or light ecru.....Long Yellow Six Weeks, Ne Plus Ultra, Veitch's Forcing, Vienna Forcing, China Red Eye, Mohawk, French Mohawk, Black Valentine.

Fully developed snap pods decidedly tough and so full of fiber as to be in more general use as green and dry shell beans than as snaps.
Plants very spreading or with semirunners.
Plants thick-stemmed; green shell pods oval-flat and purple in color.....Black Turtle Soup.
Plants thick-stemmed; green shell pods very flat and green in color (except Lightning, which is sometimes tinged with brownish purple).....Emperor William, Earliest Market, Everbearing, Lightning, Tennessee Green Pod.
Plants thick-stemmed; green shell pods changing to oval or nearly so and green in color.....White Marrow, Improved Yellow Eye, Eureka.
Plants slender-stemmed; green shell pods changing to oval or nearly so and green in color.....Snowflake, Navy, Prolific Tree, Day's Leafless.
Plants erect or at least devoid of semirunners, except Boston Favorite.
Seeds of solid white color.....Early Aroostook, French Flageolet, White Kidney, Vineless Marrow.
Seeds of solid brownish or violet shades.....Red Kidney, Canadian Wonder, Vick's Prolific Pickler, Brown Swedish.
Seeds splashed with violet, red, or similar colors with generally a pale buff as the predominating color....Improved Goddard, Boston Favorite, Marblehead Horticultural, Crimson Beauty, Warwick, French Kidney.

Phascolus vulgaris (Kidney beans)—Continued.

Plants bush—Continued,

Pods more or less yellow at snap stage.

Fully developed snap pods more or less brittle or breaking readily when bent.

Pods more or less flat.

Plants with creeping semirunners.....Rogers's Lima Wax.

Plants with drooping semirunners.....Keeney's Rustless Golden Wax.

Plants erect or devoid of semirunners.....Golden Wax, Improved Golden Wax, Wardwell's Kidney Wax, Henderson's Market Wax, Burpee's Kidney Wax, Black-Eyed Wax, Burpee's White Wax, Leopard Wax.

Pods round or nearly so.

Plants decidedly spreading and with semirunners....Crystal Wax, Refugee.

Plants more or less erect or at least devoid of semirunners. German Black Wax, Prolific Black Wax, Challenge Black Wax, Bismarck Black Wax, Pencil Pod Black Wax, Round Pod Kidney Wax, Livingston's Hardy Wax, Yosemite Wax, Double-Barrel Wax, Maule's Butter Wax, Maule's Nameless Wax of 1906, Golden Crown Wax, Jones's Stringless Wax, Valentine Wax, Monarch Wax, Golden Beauty, Speckled Wax.

Fully developed snap pods somewhat tough or not breaking readily when bent.....Davis Wax, Scarlet Flageolet Wax, Purple Flageolet Wax, Allan's Imperial Wax, Horticultural Wax, Currie's Rustproof Wax, Detroit Wax, Golden-Eyed Wax, Hodson Wax.

Plants pole.

Pods more or less green at snap stage.

Fully developed pods more or less brittle or readily breaking when bent.

Pods more or less flat at snap stage.....Arlington Red Cranberry, Extra Early Horticultural, Lazy Wife, London Horticultural, Red Cranberry, White's Prolific, Worcester Mammoth.

Pods round or nearly so at snap stage.....Black Kentucky Wonder, Burger's Stringless, Kentucky Wonder, Powell's Prolific, Scotia Pole, Tennessee Wonder, White Creaseback, White Sickle.

Pods more or less tough as fully developed snaps or not readily breaking when bent.

Seeds white.....Dutch Case Knife, Early Giant Advance, Royal Corn, Virginia Cornfield.

Seeds colored.....Brockton Pole, Childs's Horticultural, Concord Pole, Missouri Wonder, Southern Prolific, Speckled Cut Short.

Pods more or less yellow in color at snap stage.

Pods always wide and flat.....Golden Carmine-Podded Horticultural, Golden Cluster Wax, Sunshine Wax, Kentucky Wonder Wax, Landreth's Wax.

Pods wide and flat only at snap stage.....Andalusia Wax, Indian Chief, Mont d'Or Wax.

Pods always round through cross section.....Golden Champion Wax.

ARTIFICIAL KEY TO VARIETIES.

The following key, arranged on the dichotomous system, now largely adopted by botanists, is devised to enable the student to determine the variety name of any bean listed by American seedsmen. An examination of the numbers on the left will show that these numbers run from 1 to 111 in pairs and that the descriptions in each one of this set of numbers are in opposite or contrasting characters; also that at the right of these descriptions is given sometimes a variety name and sometimes a number referring to a similar number on the left of the page. To trace out a particular variety, like Currie's Rustproof, for instance, the student, beginning at 1, is referred in regular order to 2, 3, 6, 21, 48, 49, 54, 55, and finally to 56, where the name sought is given on the right.

In order to make this key compact, the descriptions are necessarily quite short, and in case of the color of seeds it has seemed desirable to disregard the minute, almost imperceptible colored area about the eye of some seeds and describe them as of a solid color, although they are not so described in the formal descriptions, or at least the minute colored area around the eye is given some mention.

1. Seeds with very large hilum, or eye, extending over at least one-fifth circumference of seed ..... *Broad Windsor and other English Broad varieties.*
1. Seeds with very small hilum, or eye, extending over not more than one-twentieth circumference of seed 2
2. Fully developed pods less than one-fourth inch in diameter and at least 14 inches in length (leaf, pod, and habit resembling cowpea) ..... *Yard Long Pole.*
2. Fully developed pods over one-fourth inch in diameter at widest portion and less than 14 inches in length (leaf, pod, and habit not resembling cowpea) 3
3. Flowers large, or at least $1\frac{1}{4}$ inches across wings; roots inclined to be thickened (Multiflora varieties) 4
3. Flowers small, or not over five-eighths inch across wings; roots never thickened, always fibrous (Lima and Kidney varieties) 6
4. Plants bush ..... *Aroostook Bush Lima, Barteldes's Bush Lima.*
4. Plants pole 5
5. Seeds white ..... *White Dutch Runner.*
5. Seeds violet-black, mottled with bluish violet ..... *Scarlet Runner.*
6. Pods never fleshy or edible even when very young (Lima beans) 7
6. Pods more or less fleshy and always edible when very young (Kidney beans) .. 21
7. Plants bush 8
7. Plants pole 12
8. Seeds yellowish, splashed with pansy violet ..... *Jackson Wonder Bush.*
8. Seeds entirely white 9
9. Pods thick and seeds very crowded in pod ..... *Dreer's Bush.*
9. Pods flat and seeds somewhat separated in pod 10
10. Leaflets extremely narrow or lanceolate ..... *Willow-Leaved Bush.*
10. Leaves not extremely narrow or lanceolate 11
11. Leaves very glossy and seeds small ..... *Wood's Prolific Bush, Henderson's Bush.*
11. Leaves not very glossy and seeds large ..... *Burpee's Bush, Wonder Bush.*

12. Seeds mottled 13
12. Seeds entirely white 14
13. Seeds mottled with brownish black ..... *Florida Butter.*
13. Seeds mottled with plum violet ..... *Mottled Pole.*
14. Leaflets extremely narrow or lanceolate ..... *Willow-Leaved Pole.*
14. Leaflets not extremely narrow nor lanceolate 15
15. Leaves very glossy ..... *Small White Pole, Wood's Improved Pole.*
15. Leaves not very glossy 16
16. Pods thick and seeds very crowded in pod ..... *Dreer's Pole.*
16. Pods flat and seeds somewhat separated in pod 17
17. Pods uniformly much twisted ..... *Long-Podded Pole.*
17. Pods not uniformly much twisted 18
18. Pods large or very large 19
18. Pods medium or large-medium 20
19. Variety early ..... *Leviathan.*
19. Varieties late ..... *Henderson's Ideal, Ford's Mammoth, King of Garden.*
20. Varieties intermediate or later in season ..... *Large White Pole, Salem Pole.*
20. Varieties early in season ..... *Extra Early Jersey Pole, Seibert's Pole.*
21. Plants pole 22
21. Plants bush 48
22. Pods yellow (wax varieties) 23
22. Pods green 31
23. Seeds entirely white 24
23. Seeds not entirely white 25
24. Pods decidedly flat ..... *Golden Cluster Wax.*
24. Pods rounded ..... *Andalusia Wax.*
25. Seeds distinctly splashed 26
25. Seeds not distinctly splashed 27
26. Seeds light yellow, splashed with red ..... *Golden Carmine-Podded Horticultural.*
26. Seeds maize yellow, splashed with dark hazel ..... *Landreth's Wax.*
27. Pods flat or nearly so at green shell stage 28
27. Pods rounded or nearly so at green shell stage 29
28. Seeds maroon to chocolate brown ..... *Kentucky Wonder Wax.*
28. Seeds purplish brown ..... *Sunshine Wax.*
29. Variety early in season ..... *Golden Champion.*
29. Varieties intermediate-late or late in season 30
30. Seeds madder brown or pansy violet ..... *Mont d'Or.*
30. Seeds bluish black ..... *Indian Chief.*
31. Seeds entirely white 32
31. Seeds not entirely white 37
32. Varieties late-intermediate or earlier in season 33
32. Varieties late or very late in season 35
33. Pods very flat ..... *Dutch Case Knife, Early Giant Advance.*
33. Pods not very flat 34
34. Pods stringless ..... *Burger's Stringless.*
34. Pods stringy ..... *White Creaseback.*
35. Pods stringless ..... *Lazy Wife.*
35. Pods stringy 36
36. Pods round or nearly so ..... *White Sickle.*
36. Pods oval-flat to flat ..... *Royal Corn, Virginia Cornfield.*
37. Seeds of at least two well-defined colors 42
37. Seeds of but one well-defined color 38
38. Variety very early in season ..... *Kentucky Wonder.*

38. Varieties late-intermediate or later in season 39
39. Pods round ..... *Powell's Prolific, Southern Prolific (round type).*
39. Pods oval-flat to very flat 40
40. Seeds entirely black ..... *Black Kentucky Wonder.*
40. Seeds solid plum violet or solid fawn 41
41. Pods stringless ..... *Arlington Red Cranberry.*
41. Pods stringy ..... *Red Cranberry, Southern Prolific (flat type).*
42. Seeds pale buff, splashed with reddish purple or purplish red (Horticultural beans) 43
42. Seeds not pale buff and not splashed with reddish purple or purplish red 44
43. Pods stringless ..... *Extra Early Horticultural, London Horticultural, Worcester Mammoth.*
43. Pods stringy ..... *Brockton Pole, Childs's Horticultural.*
44. Pods round, or nearly so, at snap stage ..... *Scotia, Tennessee Wonder.*
44. Pods flat at snap stage 45
45. Seeds round 46
45. Seeds flat or flat-oval 47
46. Seeds largely white with light buff around eye ..... *Concord Pole.*
46. Seeds dingy gray dotted with purplish red ..... *Speckled Cut Short.*
47. Seeds putty color with golden bronze-green stripes ..... *White's Prolific.*
47. Seeds pinkish drab with tan brown stripes ..... *Missouri Wonder.*
48. Pods yellow (wax varieties) 49
48. Pods green 76
49. Seeds entirely white 50
49. Seeds not entirely white 54
50. Pods silvery yellow or silvery white ..... *Crystal Wax.*
50. Pods not silvery yellow or silvery white 51
51. Pods stringy 52
51. Pods stringless 53
52. Seeds small and plants spreading ..... *Rogers's Lima Wax.*
52. Seeds large-medium and plants erect ..... *Davis Wax.*
53. Pods flat ..... *Burpee's White Wax.*
53. Pods round ..... *Jones's Stringless, Golden Crown.*
54. Seeds entirely black 55
54. Seeds not entirely black 58
55. Pods stringy 56
55. Pods stringless 57
56. Pods round or nearly so ..... *Bismarck Black Wax.*
56. Pods flat ..... *Currie's Rustproof.*
57. Pods double-barreled and very variable in size ..... *Yosemite Wax.*
57. Pods not double-barreled and not very variable in size ..... *Challenge Black Wax, German Black Wax, Pencil Pod Black Wax, Prolific Black Wax.*
58. Seeds of at least two well-defined colors 62
58. Seeds of but one well-defined color 59
59. Pods oval-round to double-barreled 60
59. Pods flat 61
60. Pods very broad or double-barreled ..... *Double-Barrel Wax.*
60. Pods oval-round ..... *Golden Beauty.*
61. Seeds straw yellow ..... *Henderson's Market Wax.*
61. Seeds plum violet or blackish purple ..... *Scarlet Flageolet Wax, Purple Flageolet Wax.*
62. Seeds evenly mottled or colored throughout 63
62. Seeds not evenly mottled or colored throughout 68

63. Pods flat and tough ..... *Hodson Wax, Horticultural Wax, Mohawk Wax.*
63. Pods round and brittle 64
64. Variety very early and plants small ..... *Valentine Wax.*
64. Varieties later than early-intermediate and plants large 65
65. Pods stringy 66
65. Pods stringless 67
66. Seeds bluish black, mottled with pale buff ..... *Refugee Wax.*
66. Seeds reddish buff, splashed with reddish purple ..... *Speckled Wax.*
67. Seeds bluish black, mottled with pale buff ..... *Refugee Stringless Wax.*
67. Seeds chocolate brown, mottled with maize yellow ..... *Livingston's Hardy Wax.*
68. Pods stringy ..... *Golden-Eyed Wax, Detroit Wax, Allan's Imperial Wax.*
68. Pods stringless 69
69. Seeds with less than one-tenth surface solid white ..... *Leopard Wax.*
69. Seeds with over three-tenths surface solid white 70
70. Seeds of a solid color around eye 71
70. Seeds mottled with at least two well-defined colors around eye 73
71. Pods oval or oval-flat through cross section ..... *Black-Eyed Wax.*
71. Pods round through cross section 72
72. Seeds black at eye ..... *Round Pod Kidney Wax.*
72. Seeds golden bronze or pansy violet at eye ..... *Maule's Nameless, Monarch Wax.*
73. Pods round to double-barreled ..... *Maule's Butter.*
73. Pods oval to flat 74
74. Plants spreading ..... *Keeney's Rustless Golden Wax.*
74. Plants erect 75
75. Seeds round and proportionally short ..... *Improved Golden Wax, Golden Wax.*
75. Seeds flat and proportionally long .. *Wardwell's Kidney Wax, Burpee's Kidney Wax.*
76. Seeds entirely white 77
76. Seeds not entirely white 83
77. Pods stringless ..... *Garden Pride.*
77. Pods stringy 78
78. Pods round or nearly so at snap stage 79
78. Pods flat at snap stage 80
79. Plants spreading in habit and late ..... *Yankee Winter.*
79. Plants very erect in habit and early ..... *White Valentine.*
80. Seeds flat or flat-oval through cross section ..... *Earliest Market, Everbearing, Emperor William.*
80. Seeds oval to round through cross section 81
81. Plants erect .... *Early Arcostook, French Flageolet, Vineless Marrow, White Kidney.*
81. Plants more or less spreading 82
82. Seeds large for field beans ..... *White Marrow.*
82. Seeds very small to medium for field beans ..... *Day's Leafless Medium, Navy Pea, Prolific Tree, Snowflake.*
83. Seeds entirely black 84
83. Seeds not entirely black 86
84. Seeds and plants decidedly purplish tinged ..... *Black Turtle Soup.*
84. Seeds and plants not perceptibly purplish tinged 85
85. Variety early-intermediate in season ..... *Black Valentine.*
85. Variety very late in season ..... *Thorburn's Prolific Market.*
86. Seeds of but one well-defined color 87
86. Seeds of at least two well-defined colors 98
87. Pods oval to round at snap stage 88
87. Pods flat to very flat at snap stage 90

88. Seeds entirely purplish brown ..... *Knickerbocker.*
88. Seeds not entirely purplish brown 89
89. Seeds burnt umber or sea green in color ..... *Burpee's Stringless Green Pod, Triumph of Frames.*
89. Seeds medium ecru, brown ocher, or straw yellow in color ..... *Cream Valentine, Giant Stringless Green Pod, Round Yellow Six Weeks, Taylor's Green Pod.*
90. Pods with inappreciable string 91
90. Pods with more or less pronounced string 92
91. Seeds carmine-violet or blackish violet ..... *Low's Champion, Warren Bush.*
91. Seeds straw yellow in color ..... *Yellow Cranberry, Bountiful.*
92. Seeds sea green in color when dry ..... *Wonder of France.*
92. Seeds not sea green in color when dry 93
93. Pods and plants decidedly purplish tinged ..... *Blue Pod Butter.*
93. Pods and plants not decidedly purplish tinged 94
94. Plants very spreading 95
94. Plants erect or very erect 96
95. Variety early-intermediate ..... *Tennessee Green Pod.*
95. Varieties very late ..... *Bayo, Pinks, Red Mexican.*
96. Varieties early or very early ..... *Ne Plus Ultra, Veitch's Forcing, Long Yellow Six Weeks.*
96. Varieties not early or very early 97
97. Seeds plum violet or garnet brown ..... *Canadian Wonder, Red Kidney, Vick's Prolific Pickler.*
97. Seeds greenish yellow or brown ocher ..... *Brown Swedish, Eureka.*
98. Seeds colored near eye only, remaining portion white 99
98. Seeds evenly splashed or colored throughout 100
99. Pods stringless ..... *Grenell's Stringless.*
99. Pods stringy ..... *Yellow Eye, Improved Yellow Eye, China Red Eye, Vienna Forcing.*
100. Pods round or oval-round at snap stage 101
100. Pods flat at snap stage 105
101. Seeds splashed with reddish shades ..... *Red Valentine, Best of All (late type), Longfellow.*
101. Seeds not splashed with reddish shades 102
102. Seeds largely pale buff in color and sparingly splashed with medium fawn. *Giant Forcer.*
102. Seeds not largely pale buff in color and not splashed with medium fawn 103
103. Plants very spreading ..... *Golden Refugee, Late Refugee.*
103. Plants erect 104
104. Seeds chocolate brown splashed with maize yellow ..... *Henderson's Full Measure.*
104. Seeds purple-violet or bluish black, splashed with pale buff ..... *Byer's Bush, Extra Early Refugee.*
105. Leaves and stems decidedly purplish tinged ..... *Lightning.*
105. Leaves and stems wholly green 106
106. Seeds splashed with reddish shades and pale buff 107
106. Seeds not splashed with reddish shades and pale buff 110
107. Pods stringless ..... *Ruby Horticultural.*
107. Pods stringy 108
108. Plants very erect ..... *Warwick, Improved Goddard, Crimson Beauty.*
108. Plants more or less spreading 109
109. Variety very late ..... *Hodson Green Pod.*
109. Varieties intermediate or late-intermediate ..... *Boston Favorite, Best of All (flat type).*

110. Plants very spreading ..... *Galega.*
110. Plants erect or very erect 111
111. Variety early ..... *Mohawk.*
111. Varieties intermediate to very late ..... *French Kidney, French Mohawk, Marblehead Horticultural.*

VARIETIES CLASSED AS DISTINCT.

The description of the bean varieties of this bulletin is most conveniently undertaken by describing first those kinds which are distinct or known by well-defined characters. After these types are described the subsidiary sorts, or kinds which are practically duplicates or synonyms of the distinct varieties may next be discussed by reference to the distinct sorts, stating in what respect, if any, they differ from the standard types.

In the following list the different sorts are grouped according to species and subdivided according to habit, whether pole or bush, or whether green or yellow in color of snap pods. Some of the varieties classed as subsidiary undoubtedly come from the same lots of seed as do some of the distinct sorts and are therefore unquestionably identical with them. In other cases, they are undoubtedly selected and harvested separately, and though often of different origin from the distinct sorts, they nevertheless sometimes so closely resemble them as to be either practically identical for all ordinary purposes, or to be classed as merely superior or deteriorated strains. There are no hard and fast rules for making a list of distinct varieties, and the following list can not therefore be said to be an absolute one. The more specialized gardening becomes, the closer are drawn the distinctions between varieties. It can not be expected that seedsmen and experimenters should agree in every case as to when newly discovered types are sufficiently different from recognized sorts to justify naming them as new varieties, or as to the time when enough change has been made in stocks of existing varieties to justify classing them as distinct.

Practically all the distinct varieties now listed by American seedsmen are included in the following list. The only omissions are certain field varieties known only to the produce trade and certain garden varieties of local name not listed by American seedsmen. After the variety name is given the number of seedsmen listing the variety in 1906, and following this are given the seedsmen from whom the seed was obtained and upon whose samples the descriptions are largely based.

ENGLISH BROAD BEANS (VICIA FABA).

This species is a comparatively unimportant one in American gardens and but little attention is paid in this country to variety types of this bean. The ten or more so-called kinds listed by American

seedsmen are not always represented by the same types from year to year, as they are in England, and for this reason no attempt is here made to describe the varieties listed by American seedsmen. The species is very different from *Phaseolus lunatus* and *P. vulgaris* not only in seed, pod, and habit of growth, but in general usefulness and value as well. Throughout Europe this bean is largely used as food for man and the plants are extensively grown for stock feeding. In Canada also the plants are grown to some extent for farm purposes, but generally are unsuited to the hot dry climate of most parts of the United States. They may possibly prove profitable in western Washington, where climatic conditions are similar to those of England, or they may prove a success in other parts of the Pacific coast, in Colorado, or in the South during winter. They are grown to a small extent in all these places, but their use has not yet become large in any part of this country. Under the varietal name of Broad Windsor the species is sold in America by 54 seedsmen. This name, however, is more commonly used in the United States to designate the whole class of English Broad beans rather than a distinct varietal type, as in England. Seed of the type commonly sold in this country as Broad Windsor is represented on Plate III, 28. Illustrations of pods and plants are shown in English seed catalogues, in Bailey's Encyclopedia of Horticulture, and in most other works on vegetable varieties.

ASPARAGUS, OR YARD LONG, BEANS (VIGNA SESQUIPEDALIS).

This species, which is variously listed in this country as Yard Long, French Yard Long, Asparagus Pole, Cuban Asparagus Pole, French Asparagus Pole, Japanese Asparagus Pole, and Long-Podded Dolichos, is an unimportant species in the garden and on the farm. There appear to be about a dozen distinct varieties in existence throughout the world, but in this country practically but one sort is in cultivation. Under the varietal name of Yard Long or Asparagus Pole the species has been listed by American seedsmen at least since 1845. The vine, pod, and leaf are very similar to the common cowpea, and the plant should more properly be classed with that vegetable rather than with garden varieties. Some seedsmen, however, recommend the plant for its dry seeds and snap pods, put it is really no more serviceable for this purpose than the common cowpea, which is so much used as snaps, green shell, and dry shell beans throughout the South. Its chief interest to amateurs is mainly on account of its very long pods, which often measure 3 feet or more in length, its climbing habit, and its very large growth of vine. Ripe seeds of the type commonly sold in this country are shown on Plate II, figure 1.

MULTIFLORA, OR RUNNER, BEANS (PHASEOLUS COCCINEUS).

This species, which has sometimes been called *Phaseolus multiflorus* by botanists, is commonly known in this country as Multiflora and in England as Runner beans. The species is a very important one in English gardening, and is represented by many varieties, but in this country practically but four sorts are in cultivation, divided into pole and bush forms.

BUSH VARIETIES.

The bush forms of the Multiflora beans are comparatively new and but little grown. Those described below tend strongly to revert to the pole form and are more or less trailing in habit and never strictly dwarf, like some of the more erect bush varieties of kidney beans.

AROOSTOOK BUSH LIMA.

Listed by 1 seedsman. Seeds tested: Jerrard, 1905, 1906.

Description.—Plant large-medium, very thick stemmed, spreading, with many drooping fruit branches and sometimes many runners, green throughout, very early for Lima or Multiflora class, late compared to Kidney varieties, long in bearing, lightly productive. Leaf very large, medium green, fairly smooth. Very floriferous. Flowers white, extremely large, being several times the size of those of Kidney varieties, 10 to 25 blossoms borne on numerous prominent flower stalks but only a few flowers setting pods. Snap pods varying greatly in size, medium in length, much curved, flat, very dark green, of very rough surface, brittle, stringy, of moderate fiber, fair as to quality, free from anthracnose. Point of pods very short, thick, and curved. Green shell pods borne on numerous large clusters high above foliage, never colored or splashed, about 4¾ inches long, each containing 3 to 5 seeds well separated in pod. Dry seeds very large, thickened, roundish oval through cross section, mostly well rounded at ends, almost straight at eye, very smooth and glossy, solid white, veining absent or indiscernible.

Comparison.—Little known and planted. Not strictly a Lima, at least not belonging to the same species as the common bush Lima, being rather a bush form of White Dutch Runner. Decidedly the earliest variety of the Multiflora class. Ripening several weeks before the true bush Limas it is claimed to be a great acquisition, especially at the extreme North, where bush Limas do not always give full crops. Where right conditions prevail, such as in the eastern part of Washington State, it may prove a valuable substitute for Limas, but in most parts of our country it is very unreliable in both earliness and productiveness and its real value is not yet exactly known. Decidedly the earliest of the Multiflora class and resembling Barteldes's Bush Lima more than any other variety, differing principally in earlier season and smaller size. Seeds fully as large and of nearly as good quality as the true Limas and pods excellent as snaps.

Confusing name.—Early Aroostook Field, a very different type of bean.

History.—Introduced in 1905 by the George W. P. Jerrard Company, who state that the seeds came from a customer.

Illustrations.—Dry seeds are similar to Barteldes's Bush Lima (Pl. IV, 25); cross sections of partially developed pods, to White Dutch Runner (Pl. V, 32 and 33); and green shell pods, to White Dutch Runner (Pl. XVIII, 1), differing principally in larger and flatter shape.

BARTELDES'S BUSH LIMA.

No longer listed by American seedsmen. Seeds tested: Denver Seed and Floral Company, 1905.

Description.—Plant very large, thick stemmed, with many long drooping fruit branches, generally with only few runners, wholly green, early for a Multiflora variety, very late compared to Kidney beans, long in bearing period, generally unproductive in most parts of the country but heavily productive in certain soils and climates. Leaf very large, dark green, fairly smooth. Exceedingly floriferous. Flowers white, extremely large, several times larger than in Kidney varieties, 12 to 30 blossoms borne on each of the numerous prominent flower stalks but only few flowers setting pods. Snap pods varying greatly in size, generally long, much curved, flat, very short, very dark green, of very rough surface, brittle, stringy, of moderate fiber, fair as to quality, free from anthracnose. Green shell pods borne on large clusters well above foliage, never colored or splashed, about 5¾ inches long, and usually containing 4 or 5 seeds well separated in pod. Dry seeds very large, thickened, flattish oval through cross section, mostly well rounded at ends, straight at eye, very smooth and glossy, solid white, veining absent or indiscernible.

Comparison.—Little known or planted. Grown mostly in California, Colorado, and other parts of the West, where it seems to do well. Not strictly a Lima, being rather a bush form of White Dutch Runner and similar to Aroostook Bush Lima previously described, differing principally in larger vine, seed, and pod, greater productiveness, and later season. Under right conditions, it gives green shell pods considerably before White Dutch Runner Pole or the true bush Limas, but season and productiveness are very uncertain in most parts of this country and its real usefulness is not yet fully known. Its green shell beans are almost equal to Limas and its snap pods much superior to the tough Kidney varieties such as Black Valentine and Davis Wax. Prof. L. H. Bailey states the roots are not always fleshy like those of White Dutch Runner and therefore not truly perennial, though probably, with some selection, fleshy roots and a perennial type could be obtained and perpetuated in such climates as southern California. An earlier strain of this variety has recently appeared as Bush Multiflora.

Synonyms.—California Butter (of Haines, Lee, etc.), Mexican Bush Lima.

History.—First introduced about 1890 by F. Barteldes & Co., who state that the seed came from Colorado. The variety was tested in 1886 by L. H. Bailey, who gives a full description of it in Bulletin No. 87 of the Cornell University Agricultural Experiment Station.

Illustrations.—Dry seeds are illustrated on Plate IV, 25; cross sections of partially developed green shell pods resemble White Dutch Runner (Pl. V, 32 and 33), as also the green shell pods (Pl. XVIII, 1), differing principally in larger size and flatter shape.

POLE VARIETIES.

The important varieties of this species are all of the pole form, the value of the bush forms being not yet fully established. For a complete description of existing pole varieties the student should consult English seed catalogues.

SCARLET RUNNER POLE.

Listed by 106 seedsmen. Seeds tested: Buckbee, 1900; Thorburn, 1901, 1902, 1905.

Description.—Vine of very large growth, of fair climbing habit, moderately branched, very thick stemmed, much tinged with purple at stems, very long in bearing, moderately productive. Leaf of medium size, very dark green, with under side of veins

much tinged with purple. Flower stalks very large and numerous. Blossoms brilliant scarlet in color, extremely large, very ornamental, about twice the size of those of Kidney varieties, and with 20 to 40 on each flower stalk, but only few setting pods. Snap pods uniform and long-medium in size, much curved, flat, very dark green, often purplish tinged along sutures, of very rough surface, brittle, of very hard flesh, stringy, of moderate fiber, of fair quality, entirely free from anthracnose. Point of pod very short, thick, and curved. Green shell pods full on outside between seeds, decidedly purplish tinged at sutures, about 6¼ inches long, and containing five seeds somewhat separated in pod. Dry pods easy to thrash. Dry seeds very large, of medium length, flattish oval through cross section, generally well rounded at ends, usually larger at one end than at the other, mostly straight at eye, violet-black in color except mottled with bluish violet at back and ends.

Comparison.—Little known or cultivated in this country, but largely grown throughout Europe, being used for green shell beans the same as Limas, which can not be successfully grown in the cool climate of England and other European countries. A great many varieties are known to the seed trade, but in the United States only Scarlet Runner and White Dutch Runner are in use. Both varieties are wholly different in appearance and growth of vine from other American beans and hardly recognizable as edible to most Americans, though, nevertheless, they make excellent snaps. They succeed especially well in California, where they are said to give a larger and more continuous supply of snap pods than any other variety. Highly recommended for trial not only for edible pods but also as an ornamental climber.

History.—Grown in this country at least since 1800, and one of the first cultivated varieties.

Illustrations.—Seeds are same size and shape as White Dutch Runner (Pl. IV, 28); snap pods same as White Dutch Runner (Pl. XVIII, 1); cross sections of immature green shell pods also resemble same variety (Pl. V, 32 and 33).

WHITE DUTCH RUNNER POLE.

Listed by 40 seedsmen. Seeds tested: Burpee, 1903; Thorburn, 1897, 1901, 1902, 1905.

Description.—Same as given for Scarlet Runner, except stems and pods are solid green and blossoms and seeds solid white in color.

Comparison.—Usefulness and value about the same as explained for Scarlet Runner.

Synonyms.—Childs's Extra Early Pole Lima, Isbell's Perfect Pole Lima.

History.—One of the oldest existing varieties. Listed by American seedsmen at least since 1825.

Illustrations.—Dry seeds are illustrated on Plate IV, 28; cross section of immature green shell pods on Plate V, 32 and 33, and snap pods on Plate XVIII, 1.

LIMA BEANS (PHASEOLUS LUNATUS).

This species is more extensively cultivated in the United States than in any other country, though there are many forms in use throughout South America and in tropical countries which are not known in the United States. Nearly all foreign sorts are merely local varieties and owing to the fact that they usually have colored seeds, which are not popular in this country, and are also too late in season to be suitable for our climate they are not referred to in the following descriptions. The species is usually divided by American seedsmen into pole and bush varieties, as follows:

BUSH VARIETIES.

The bush varieties of the Lima bean are now used extensively throughout the United States and in some localities have replaced to a considerable extent the pole varieties, which were the only forms known until the introduction of Henderson's Bush Lima in 1889.

BURPEE'S BUSH LIMA.

Listed by 136 seedsmen. Seeds tested: Burpee, 1897, 1898, 1900, 1901, 1904; May, 1897; Thorburn, 1901, 1904.

Description.—Plant large, thick stemmed, erect to somewhat spreading, with occasional runners, always with many outspreading branches, late-intermediate in season, long in bearing, heavily productive. Leaf very large, dark green. Flowers white. Green shell pods dark green, of smooth surface, moderately curved, flat, uniform in size, very large for dwarf Limas, medium for pole Limas, very wide, about 4⅛ inches long, and generally containing 3 or 4 seeds somewhat separated in pod. Point or spur of pod absent or insignificant. Pods borne in clusters of moderate size well up from ground and well toward center of plant. Quality of green shell beans excellent. Dry seeds very large but proportionally short in length, very flattish through cross section, generally well rounded, usually larger at one end than at other, incurved at eye, very distinctly veined, white with slight greenish tinge.

Comparison.—This variety and Henderson's Bush are at present by far the most largely grown bush Limas, though each will probably in time be replaced by other more desirable sorts, the former by Wood's Prolific Bush, and the latter by Wonder Bush. Unsurpassed for productiveness, high quality, and immense, handsome, showy pods and seeds, or about equal in these respects to Wonder Bush and Wood's Prolific Bush, but not adapted to as many conditions or as generally serviceable as Henderson's Bush and Wood's Prolific Bush. Too late for maturing full crops at the extreme north and more subject to mildew than the glossy-leaved or small-seeded sorts. Most like Wonder Bush, differing principally in larger growth, more spreading habit, and later season.

Synonyms.—Elliott's Bush Lima, Large White Bush Lima, Mammoth Bush Lima, Willet's Bush Lima.

History.—Introduced in 1890 by W. Atlee Burpee & Co., who state the variety originated with Ashur Palmer, of Kennett Square, Pa. It is said to have come from a single bush plant found about 1884 in a field of King of Garden Pole Lima on Mr. Palmer's farm.

Illustrations.—Green shell pods are illustrated on Plate XXI, 2; cross section of green shell pod and of dry seed is similar to Large White Pole (Pl. V, 31, and Pl. III, 22, respectively).

DREER'S BUSH LIMA.

Listed by 68 seedsmen. Seeds tested: Burpee, 1898, 1900, 1903; Dreer, 1906.

Description.—Plant large, very coarse branched, very spreading, almost creeping in habit, with many runners lying flat on the ground, late, long in bearing, heavily productive. Leaf very large, of a peculiar grayish green color, with a smooth but not glossy surface. Flowers white. Green shell pods medium green, of smooth surface, straight, somewhat turned back at stem end, uniform in size, large-medium for dwarf Limas, small for pole Limas, very thick through cross section, about 2⅞ inches long, usually containing 3 or 4 seeds tightly crowded in pod, decidedly rigid at ventral suture. Point or spur of pod absent or insignificant. Pods borne in moderate-sized clusters close to ground. Quality of green shell beans excellent. Dry seeds large,

very short, almost as wide as long, flattish oval through cross section, truncate or rounded at ends, generally larger at one end than at other, straight or rounded at eye, very distinctly veined, white with slight greenish tinge.

Comparison.—One of the three most largely grown as well as the latest in season of the bush Limas and the only bush variety of the potato or thick-seeded class. Often considered as first in productiveness and quality, but experiments vary greatly, many tests giving first place to Dreer's Bush. Succeeds especially well on light soil and in dry seasons. Probably a somewhat more reliable cropper than Burpee's Bush but not as sure or as generally serviceable as Wood's Prolific Bush, while pods are too close to the ground to be easily gathered and vines more subject to mildew than the small-seeded, glossy-leaved sorts. Very different in habit from other bush Limas. Unlike Burpee's Bush principally in having shorter, much thicker pods and seeds, more spreading habit, and narrower, more grayish green leaves. Seeds, pods, and leaves same as Dreer's Pole except larger.

Synonyms.—Challenger Bush Lima, Dallas Bush Lima, Kumerle Bush Lima, Potato Bush Lima, Salzer's Bush Lima, Thorburn's Bush Lima.

History.—Introduced in 1891 by Henry A. Dreer and derived from the same stock as Kumerle or Thorburn's Bush, which was introduced two years previous to Dreer's Bush.

Illustrations.—Dry seed, green shell pod, cross section of green shell pod, and leaf are similar to Dreer's Pole. (Pl. II, 23; Pl. XXII, 3; Pl. V, 36; and Pl. XXIV, 7, respectively.)

HENDERSON'S BUSH LIMA.

Listed by 136 seedsmen. Seeds tested: Burpee, 1900, 1901; Ferry, 1903; Fish, 1903, 1904; Henderson, 1905; May, 1897; Thorburn, 1901.

Description.—Plant small for a bush Lima, slender stemmed, very erect, bushy, without runners or decidedly spreading branches, very early, long in bearing, heavily to moderately productive. Leaf small, very dark, glossy green in color, very smooth, very stiff, moderately wide across leaflets. Very floriferous. Flowers white. Green shell pods rich, dark green, of smooth surface, straight, very uniform in size, very small, very flat, moderately wide, about $2\frac{3}{4}$ inches long, containing 3 or 4 seeds well separated in pod. Point or spur of pod very small or almost absent. Pods borne in numerous large clusters well above plant and well toward center. Quality of green shell beans fair to good. Dry seeds large, proportionally short, decidedly flattish through cross section, rounded or slightly truncate at ends, larger at one end than at other, almost straight at eye, very distinctly veined, solid creamy white.

Comparison.—One of the two most largely grown bush Limas and decidedly the earliest of the true Lima class. As sure a cropper as any, making crops in extremely dry or wet weather and under other adverse conditions where Burpee's Bush and Dreer's Bush are often failures. Unusually free from mildew, almost as hardy as Jackson Wonder, and an especially good variety on light soils. As it endures extremely hot sun much better than the larger seeded sorts it has always been a favorite in the South, while in the extreme North it matures good crops where late varieties often fail to do so. The quality of its green shell beans is not generally considered equal to that of Burpee's Bush or Dreer's Bush, but the difference is not so great as is usually claimed, some people, in fact, having little choice between the three varieties. Most like Wood's Prolific Bush, differing principally in smaller growth, a few days earlier season, smaller seeds, and smaller pods without twisting from side to side. Pods similar to Willow-Leaved Bush and Jackson Wonder and except for smaller size the same as those of Small White Pole.

Synonyms.—Carolina Bush Lima, Sieva Bush Lima, Small White Bush Lima.

History.—Introduced in 1889 by Peter Henderson & Co., and described by them as having originated from a single plant found in the vicinity of Lynchburg, Va.,

about 1883. In 1885 the variety passed into possession of T. W. Wood & Sons, who sold the entire stock in 1887 to Peter Henderson & Co.

Illustrations.—The dry seed is similar to Small White Pole Lima (Pl. IV, 27), as also are the cross section, green shell pod, and leaf (Pl. V, 34; Pl. XXI, 5; and Pl. XXIV, 5, respectively), all differing principally in larger size.

JACKSON WONDER BUSH LIMA.

Listed by 7 seedsmen. Seed tested: Burpee, 1898, 1901; Hastings, 1905; Thorburn, 1897.

Description.—Plant large-medium in size, somewhat slender stemmed, productive of many erect fruit stems, quite spreading in habit, often producing many runners, early-intermediate in season, long in bearing, heavily productive. Leaf of medium size, very dark, glossy green in color, very smooth, very stiff, with long, narrow, pointed leaflets. Very floriferous. Flowers white. Green shell pods of a rich, dark green color, of very smooth surface, straight, very flat, very uniform in size, small-medium, moderately wide, about 3¼ inches long, and containing 3 or 4 seeds much separated in pod. Point or spur of pod very small or almost wanting. Pods borne prominently above foliage and in very large clusters. Quality of green shell beans fair to good. Dry seeds of medium size, proportionally short, very flattish through cross section, truncate or rounded at ends, decidedly larger at one end than at other, straight at eye, flesh yellowish in color, freely splashed with pansy violet, sometimes almost solid pansy violet.

Comparison.—Little known and planted. Cultivated mostly in the South. The hardiest of all bush Limas and about as sure a cropper as Henderson's Bush, from which it differs in larger vine, greater productiveness, larger pods, and large seeds of different color. Possesses all the good qualities of the small-seeded sorts, but never popular because of objectionable runners and colored seeds. Vine much more spreading than Burpee's Bush, but not creeping in habit like Dreer's Bush. Leaf indistinguishable from that of Willow-Leaved Bush and pods also resembling same variety, differing principally in slightly narrower, longer shape and seed of larger size.

Synonym.—Steckler's Calico Bush Lima.

History.—Introduced in 1891 by several American seedsmen and said to have originated in the vicinity of Atlanta, Ga.

Illustrations.—Dry seeds are illustrated on Plate II, 22; green shell pod and cross section of same are similar to Small White Pole (Pl. XXI, 5, and Pl. V, 34, respectively); leaflets are about twice as wide as those of Willow-Leaved Pole (Pl. XXIII, 2), approaching more the shape of Henderson's Bush.

WILLOW-LEAVED BUSH LIMA.

Listed by 3 seedsmen. Seeds tested: Burpee, 1900, 1901; May, 1904, 1905.

Description.—Plant very small for a bush Lima, somewhat slender stemmed, very erect, bushy, without runners or decided spreading branches, very early, long in bearing, heavily to moderately productive. Leaf of medium size, of very dark, glossy green color, very smooth, very stiff, and with very long, narrow, pointed leaflets; the leaves, however, are very irregular in form, often approaching the broad shape of Henderson's Bush Lima. Very floriferous. Flowers white. Green shell pods of dark green color, of smooth surface, straight, very flat, very uniform in size, moderately wide, small for a bush Lima, about 2⅞ inches long, and containing 3 or 4 seeds much separated in pod. Point or spur of pod very small or almost absent. Pods borne on numerous large clusters well above plant and well toward the center. Quality of green shell beans fair to good. Dry seed large, proportionally short, decidedly flat

through cross section, rounded or slightly truncate at ends, larger at one than at other, almost straight at eye, very distinctly veined, solid creamy white.

Comparison.—Little known and planted. Cultivated mostly in the South. Of usefulness similar to Henderson's Bush, but apparently less productive and hardy. More like that variety than any other, differing principally in shape of leaves, decidedly smaller vine, and slightly larger and proportionally narrower pods, which are same as those of Willow-Leaved Pole except smaller.

History.—Introduced in 1901 by W. Atlee Burpee & Co., as Burpee's Willow-Leaved Bush.

Synonyms.—Burpee's Willow-Leaved Bush Lima, Southern Willow-Leaved Sewee Lima.

Illustrations.—Dry seed is similar to Small White Pole (Pl. IV, 27); green shell pod and cross section of same to Small White Pole (Pl. XXI, 5, and Pl. V, 34, respectively); and leaf to Willow-Leaved Pole (Pl. XXIII, 2).

WONDER BUSH LIMA.

Listed by 24 seedsmen. Seeds tested: Dreer, 1905, 1906; Ferry, 1902, 1904; Fish, 1904.

Description.—Plant large, thick stemmed, erect, compact, with few drooping branches, but without real runners, intermediate in season, long in bearing, heavily productive. Leaf very large, dark green. Flowers white. Green shell pods dark green, of smooth surface, moderately curved, flat, very uniform in size, wide, very large for dwarf Limas, medium for pole Limas, about 4⅛ inches long, usually containing 3, sometimes 4, seeds well separated in pod. Point or spur of pod absent or insignificant. Pods borne in clusters of moderate size, well up from ground and well toward center of plant. Quality of the green shell beans excellent. Dry seeds very large, proportionally short, very flattish through cross section, larger at one end than at other, incurved at eye, very distinctly veined, white with slightly greenish tinge.

Comparison.—New and valuable but as yet not extensively cultivated. The best of large-seeded bush Limas for general cultivation, and largely replacing the old type of Burpee's Bush Lima, some seedsmen, in fact, having discarded the old type altogether, selling only this improved strain. Differs from its parent principally in earlier season, more bushy, compact habit, and entire freedom from runners. Although not quite as large or as vigorous in vine, its pods and seeds are fully as large and numerous as those of its parent.

History.—Introduced in 1898 as Dreer's Wonder Bush by Henry A. Dreer, who writes that the variety is a selection of Burpee's Bush and was first discovered on Long Island.

Synonyms.—Burpee's Quarter Century Bush Lima, Dreer's Wonder Bush Lima, Quarter Century Bush Lima.

Illustrations.—Dry seed and cross section of green shell pod are similar to Large White Pole (Pl. III, 22, and Pl. V, 31, respectively); green shell pods same exactly as Burpee's Bush (Pl. XXI, 2).

WOOD'S PROLIFIC BUSH LIMA.

Listed by 18 seedsmen. Seeds tested: Burpee, 1901; Wood, 1904, 1905.

Description.—Plant of medium size, somewhat slender stemmed, very erect and bushy, without runners or decided spreading branches, early, long in bearing, heavily productive. Leaf small for a bush Lima, very dark, glossy green, very smooth, moderately wide across leaflets. Very floriferous. Flowers white. Green shell pods dark green, of smooth surface, very uniform in shape, straight at back and front but often curling from side to side, of medium size, moderately wide, very flat, about 3½

inches long, and containing 3 or 4 seeds well separated in pod. Point or spur of pod very small or almost absent. Pods borne in large, numerous clusters well above plant and well toward its center. Quality of green shell beans fair to good. Dry seeds large, proportionally short, decidedly flattish through cross section, rounded or slightly truncate at ends, larger at one end than at other, almost straight at eye, very distinctly veined, solid creamy white.

Comparison.—New and as yet not extensively cultivated, but probably will in time largely replace the old Henderson's Bush, as the objectionable small seed and pod of that variety have been much enlarged in this valuable sort. Excepting for being a few days later, all the excellent qualities of the Henderson's Bush have been fully retained or perceptibly increased. Vine somewhat larger and more vigorous than Henderson's Bush and pods straighter and slightly curling from side to side. Pods same as Wood's Improved Pole except smaller.

Synonyms.—Henderson's Improved Bush Lima, King's Improved Bush Lima, Prolific Bush Lima, St. Louis Seed Co.'s Improved Bush Lima, Tucker's Prolific Bush Lima.

History.—Introduced in 1899 by T. W. Wood & Sons, who state that it is a sport from Henderson's Bush and was obtained from a farmer near Richmond, Va.

Illustrations.—Dry seeds are similar to Wood's Improved Pole (Pl. IV, 26); green shell pod and cross section of same to Wood's Improved Pole (Pl. XXI, 4, and Pl. V, 35, respectively); leaf to Small White Pole (Pl. XXIV, 5).

POLE VARIETIES.

The pole sorts described below represent as great variation in season and productiveness of plant and of color, shape, and size of pod as do the bush varieties. All are of American origin.

DREER'S POLE LIMA.

Listed by 58 seedsmen. Seeds tested: Burpee, 1900; Dreer, 1906; Henderson, 1902; Johnson & Stokes, 1904, 1905; May, 1897; Thorburn, 1901.

Description.—Vine of very large growth, of good climbing habit, much branched, thick stemmed, very late, very heavily productive, long in bearing. Leaf very large, dark green, smooth, of narrower and more pointed leaflets than the large, flat-seeded sorts. Flowers white. Green shell pods medium green, straight, generally turned back at stem end, uniform in size, large, wide, exceedingly thick, ridged along ventral suture, about $3\frac{3}{4}$ inches long, and usually containing 4 or 5 seeds very crowded in pod. Point or spur of pod absent or insignificant. Quality of green shell beans excellent. Dry seeds large, almost as wide as long, flattish oval through cross section, rounded or truncate at ends, generally larger at one end than at other, straight or rounded at eye, very distinctly veined, white with slight greenish tinge.

Comparison.—One of the most largely grown pole Limas and the only potato-seeded variety of the class. More largely planted in the East and North than in the South and West. Excellent for home or garden, and next to the small-seeded sorts the most certain cropper and often the most productive. Generally described as the best in quality, but tastes differ greatly in deciding quality in Limas and the difference between Lima varieties in this particular can not be said to be important. Pod and leaf very similar to Dreer's Bush Lima, differing principally in larger size and later season.

Synonyms.—Challenger Pole Lima, Elliott's Improved Pole Lima, Noll's Ideal Potato Pole Lima, Potato Pole Lima, Shotwell's Pole Lima, Walter's Prolific Pole Lima.

History.—Introduced in 1875 by Henry A. Dreer, who writes that the variety was obtained about 1857 from H. Kimber, of Kimberton, Pa. The old stock of Dreer's Pole

is now probably extinct, the larger-podded Challenger having been substituted for the original type introduced by Henry A. Dreer.

Illustrations.—Dry seeds, leaf, green shell pods, and cross section of green shell pod are illustrated on Plate II, 23, Plate XXIV, 7, Plate XXII, 3, and Plate V, 36, respectively.

EXTRA EARLY JERSEY POLE LIMA.

Listed by 71 seedsmen. Seeds tested: Burpee, 1900; Henderson, 1902; Johnson & Stokes, 1904-1906; May, 1897; Thorburn, 1901.

Description.—Vine of very large growth, of good climbing habit, much branched, thick stemmed, early, heavily to moderately productive, moderate to long in bearing period. Leaf very large, dark green. Flowers white. Green shell pods dark green, moderately curved, fairly uniform, of medium size, wide, flat, about 4 inches long, and usually containing 3 or 4 seeds somewhat separated in pod. Point or spur of pod absent or insignificant. Quality of green shell beans excellent. Dry seeds very large, almost as wide as long, very flattish through cross section, generally well rounded at ends, usually larger at one end than at other, incurved at eye, very distinctly veined, white with slight greenish tinge.

Comparison.—A well-known standard variety, being perhaps one of the six most largely grown pole Limas. Although generally satisfactory for home or market, it can not be recommended very highly because Seibert's Pole and Leviathan Pole are so much better for every purpose for which this variety is usually recommended. Most like Seibert's Lima, differing principally in smaller pods, smaller seeds, and less productive vines. Often misrepresented by inferior and mixed stocks in same way as described for King of Garden.

Synonyms.—Bliss's Extra Early Pole Lima and probably several more whose identification has not as yet been positively determined.

History.—Introduced about 1883. Same as the variety known at that time as Bliss's Extra Early. Introduced in 1878 by the late firm of B. K. Bliss & Sons.

Illustrations.—Dry seeds are similar to Large White Pole Lima (Pl. III, 22); green shell pods to Burpee's Bush Lima and Seibert's Pole Lima (Pl. XXI, 2 and 3); and cross section of pod to Large White Pole Lima (Pl. V, 31).

FLORIDA BUTTER POLE LIMA.

No longer listed by American seedsmen. Seeds tested: Hastings, 1905.

Description.—Trials too poor to make full description of type, but vine and pod evidently of same character as those of the small-seeded Limas, differing principally from most of this class in later season and larger growth. Pods borne in remarkably large clusters, curled from side to side, and almost as large as those of Wood's Improved Pole Lima. Dry seeds medium in size for a Lima, almost as wide as long, flattish through cross section, truncate or rounded at ends, invariably straight at eye, milky white, blotched with brownish black at back and one end.

Comparison.—Little known and planted. Apparently suitable only for the South, where it is said to be the most prolific of all Limas and an especial favorite of certain Florida farmers. Further trials are necessary before positively stating its real usefulness and value.

History.—Probably of southern origin. Apparently last listed by American seedsmen in 1901, in which year it was catalogued by H. B. Hastings & Co. Possibly same as one of the speckled Limas listed by American seedsmen eighty or more years ago, but since dropped from seed lists.

Illustrations.—Dry seeds are illustrated on Plate II, 21; green shell pods are similar to Wood's Improved Pole Lima (Pl. XXI, 4) and cross section of pod to Wood's Improved Pole Lima (Pl. V, 35).

FORD'S MAMMOTH POLE LIMA.

Listed by 27 seedsmen. Seeds tested: Fish, 1903; Johnson & Stokes, 1902, 1904–1906; Thorburn, 1897; Vaughan, 1906.

Description.—Vine of very large growth, of good climbing habit, much branched, thick stemmed, late, very heavily productive, long in bearing. Leaf very large, dark green. Flowers white. Green shell pods dark green, straight, inclined to curl from side to side, somewhat depressed between seeds, fairly uniform in size, very large, of good width, distinctly narrow compared with other Limas, about 6 inches long, and usually containing 5 or 6 seeds somewhat separated in pod. Point or spur of pod absent or insignificant. Quality of green shell beans excellent. Dry seeds very large, almost as wide as long, very flattish through cross section, generally well rounded at ends, usually larger at one end than at other, incurved at eye, very distinctly veined, white with slight greenish tinge.

Comparison.—A well-known standard variety, being perhaps one of the six most largely grown pole Limas. Longest podded of all Limas excepting Long-Podded Pole. Same as King of Garden in general usefulness and value, differing principally in longer, proportionally narrower, and straighter pods with more tendency to curl from side to side. Much misrepresented by inferior and mixed stocks in same way as described for King of Garden.

History.—Introduced in 1893 by Johnson & Stokes, who write that the variety originated with James Ford, a market gardener of Philadelphia, Pa.

Illustrations.—Dry seeds and cross section of green shell pods are similar to Large White Pole Lima (Pl. III, 22, and Pl. V, 31, respectively); green shell pods resemble King of Garden (Pl. XXII, 1).

HENDERSON'S IDEAL POLE LIMA.

Listed by 1 seedsman. Seeds tested: Henderson, 1906.

Description.—Vine of very large growth, of good climbing habit, much branched, thick stemmed, late, very heavily productive, long in bearing. Leaf very large, dark green. Flowers white. Green shell pods dark green, very straight, flat, very uniform in size, very large, about 5½ inches long, and usually containing 5 or 6 seeds well separated in pod. Point or spur of pod absent or insignificant. Quality of green shell beans excellent. Dry seeds very large, almost as wide as long, very flattish through cross section, generally well rounded at ends, usually larger at one end than at other, incurved at eye, very distinctly veined, white with slight greenish tinge.

Comparison.—New and as yet little known and planted. For combination of large, straight, handsome pods, large seed, and great productiveness, this variety is superior to any other sort. It is the best of all Limas for main crop, and although merely an improvement over King of Garden, it is so distinctly superior to present type of that variety as to deserve a new name. Its superiority is especially noticeable in its straighter pods and freedom from the many undersized, curved, twisted, and imperfectly shaped pods such as are commonly found in most stocks of King of Garden.

History.—Introduced in 1906 by Peter Henderson & Co.

Illustrations.—Dry seeds and cross section of green shell pods are similar to Large White Pole Lima (Pl. III, 22, and Pl. V, 31, respectively), and green shell pods to King of Garden (Pl. XXII, 1).

KING OF GARDEN POLE LIMA.

Listed by 122 seedsmen. Seeds tested: Burpee, 1897, 1900; Ferry, 1906; Fish, 1903; Johnson & Stokes, 1902, 1904, 1906; Thorburn, 1901, 1904, 1905.

Description.—Vine of very large growth, of good climbing habit, much branched, thick stemmed, late, very heavily productive, long in bearing. Leaf very large,

dark green. Flowers white. Green shell pods dark green, slightly curved, flat, uniform in size, wide, very large, about 5¾ inches long, and usually containing 4 to 6 seeds somewhat separated in pod. Point or spur of pod absent or insignificant. Quality of green shell beans excellent. Dry seeds very large, almost as wide as long, very flattish through cross section, generally well rounded at ends, usually larger at one end than at other, incurved at eye, very distinctly veined, white with slight greenish tinge.

Comparison.—More largely grown than any other pole Lima. For combination of large, handsome pods, large seed, and great productiveness, this variety is surpassed only by Ford's Mammoth and Henderson's Ideal. Like many others of the standard pole Limas, it is often misrepresented by inferior and mixed stocks, much of the seed which is now sold as King of Garden being neither planted nor selected especially for seed, but bought of farmers who originally had sown the seed for the produce trade. The cheaper seed of the Lewis variety, so largely planted in southern California as a field bean, and inferior stocks of King of Garden and other varieties are thus often disposed of by so-called seed growers. More like Large White Lima and Henderson's Ideal than any other pole Lima, differing from former principally in later season and larger vine, pod, and seed.

Synonyms.—Schwill's Monstrous Pole Lima, and probably several more whose identification has not yet been positively determined.

History.—Introduction in 1880 by Frank S. Platt. Developed by selection from Large White Pole Lima.

Illustrations.—A green shell pod is illustrated on Plate XXII, 1; dry seed and cross section of pod are similar to Large White Pole Lima (Pl. III, 22, and Pl. V, 31, respectively).

LARGE WHITE POLE LIMA.

Listed by 134 seedsmen. Seeds tested: Burpee, 1897, 1900; Ferry, 1906; Johnson & Stokes, 1906; May, 1897; Thorburn, 1901, 1905.

Description.—Vine of very large growth, of good climbing habit, much branched, thick stemmed, intermediate in season, heavily productive, long in bearing. Leaf very large, dark green. Green shell pods dark green, moderately curved, flat, uniform in size, very wide, large-medium, about 4½ inches long, and usually containing 3 to 5 seeds somewhat separated in pod. Point or spur of pod absent or insignificant. Quality of green shell beans excellent. Dry seeds very large, almost as wide as long, very flattish through cross section, generally well rounded at ends, usually larger at one end than at other, incurved at eye, very distinctly veined, white with slight greenish tinge.

Comparison.—Next to King of Garden, the most largely grown of all pole Limas. Excellent for either home or garden and suitable for all sections of the country. Not quite so large or so handsome as King of Garden and Henderson's Ideal, but a good all-round sort and always attractive and salable. Often misrepresented by inferior and mixed stocks in same way as King of Garden. Intermediate between Extra Early Jersey and King of Garden in season, productiveness, and size of pod and seed.

Synonyms.—May's Champion Pole Lima and probably several more whose identification has not as yet been positively determined.

History.—Name has been in common use in this country for over one hundred years, though the type has probably not always been the same as the present one.

Illustrations.—Dry seeds and a cross section of a green shell pod are illustrated on Plate III, 22, and Plate V, 31, respectively. Green shell pods are similar to Burpee's Bush Lima (Pl. XXI, 2).

LEVIATHAN POLE LIMA.

Listed by 6 seedsmen. Seeds tested: Henderson, 1902, 1904, 1906.

Description.—Vine of very large growth, of good climbing habit, much branched, thick stemmed, green throughout, early, heavily productive, of moderate to long bearing period. Leaf very large, dark green. Flowers white. Green shell pods dark green, very straight, flat, very uniform in size, wide, very large, about 5¼ inches long, and usually containing 4 to 6 seeds somewhat separated in pods. Point or spur of pod absent or insignificant. Quality of green shell beans excellent. Dry seeds very large, almost as wide as long, very flattish through cross section, generally well rounded at ends, usually larger at one end than at other, incurved at eye, very distinctly veined, white with slight greenish tinge.

Comparison.—New and as yet little known or planted. Decidedly larger, straighter, and more handsome than either Seibert's Pole or Extra Early Jersey Pole, decidedly the earliest of the large-seeded sorts, and by far the best extra early large-seeded Lima. Excellent for either home or market. Most like Henderson's Ideal, differing principally in smaller, fewer seeded, and proportionally narrower pods, earlier season, and less vigorous and productive vines.

History.—Introduced in 1900 by Peter Henderson & Co., who write that the variety came from Bergen County, N. J.

Illustrations.—A green shell pod is illustrated on Plate XXII, 2. Dry seed and cross section of pod are similar to Large White Pole Lima (Pl. III, 22, and Pl. V, 31, respectively).

LONG-PODDED POLE LIMA.

Listed by 1 seedsman. Seeds tested: Childs, 1905, 1906.

Description.—Vine of very large growth, of good climbing habit, much branched, thick stemmed, green throughout, very late, lightly productive, long in bearing. Leaf very large, dark green. Flowers white. Green shell pods dark green, moderately curved, flat, much inclined to curl and twist from side to side, varying considerably in size, very wide, very large, about 6 inches long, and usually containing 4 to 6 seeds somewhat separated in pod. Point or spur of pod absent or insignificant. Quality of green shell beans excellent. Dry seed very large, almost as broad as long, very flattish through cross section, generally well rounded at ends, usually larger at one end than at other, incurved at eye, very distinctly veined, white with slight greenish tinge.

Comparison.—Little known and planted. Interesting for immense size of pods, which are often larger than those of any other variety, but so unproductive and pods so twisted, curly, and unattractive that variety is of little practical value. Pod and vine most like King of Garden, differing principally in productiveness and in curly, twisted pods.

History.—Introduced in 1905 by John Lewis Childs, who writes that the variety was developed by A. Vander Veer, of Queens, N. Y.

Illustrations.—Dry seed and cross section of pod are similar to Large White Pole Lima (Pl. III, 22, and Pl. V, 31, respectively); green shell pod is about as long and wide as King of Garden (Pl. XXII, 1).

MOTTLED POLE LIMA.

No longer listed by American seedsmen. Seeds tested: Sample obtained from an unknown fruit peddler in Washington, D. C., during summer of 1904.

Description.—Vine of very large growth, of good climbing habit, much branched, thick stemmed, green throughout, intermediate-late in season, heavily productive, long in bearing. Leaf small for a Lima, very dark green, smooth, almost as glossy and stiff as the small-seeded Limas, moderately wide across leaflets. Flowers white.

Green shell pods medium green with slight suggestion of veining and mottling, especially near dorsal and ventral sides, of somewhat coarse surface, moderately curved, very flat, often much depressed between seeds, uniform in size, wide, much narrowed at stem end, large-medium, about 3⅝ inches long, and rarely containing more than 3 seeds, always much separated in pods. Point or spur of pod very small or almost absent. Pods borne in large clusters. Quality of green shell beans excellent. Dry seeds very large, almost as wide as long, very flattish through cross section, rounded or truncate at ends, straight or incurved at eye, white with plum-violet splashing.

Comparison.—Little known and planted. Interesting because of brilliantly splashed seeds, but apparently of no practical value except possibly for hardiness. Pods often imperfectly shaped, very flat for a large-seeded sort, and decidedly unattractive in color and smooth surface. Most like Large White Pole Lima, but differing greatly in color, texture, smaller size, and greater flatness of both seed and pod, and in decidedly smaller, darker green, smoother, and more glossy leaves, which approach in color, size, and texture those of Small White Pole Lima.

History.—Probably same as one of the large-seeded spotted Limas catalogued by seedsmen about 1865 and still found growing in private gardens in the Southern States.

Illustrations.—Dry seeds are illustrated on Plate III, 25, and green shell pods on Plate XXI, 1.

SALEM MAMMOTH POLE LIMA.

Listed by 5 seedsmen. Seeds tested: Johnson & Stokes, 1905, 1906.

Description.—Vine of very large growth, of good climbing habit, much branched, thick stemmed, green throughout, late, heavily productive, long in bearing. Leaf very large, dark green. Flowers white. Green shell pods dark green, much curved, flat, uniform in size, very wide, large-medium, about 4 inches long, and usually containing 3 seeds somewhat separated in pod. Point or spur of pod absent or insignificant. Quality of green shell beans excellent. Dry seeds very large, almost as broad as long, flattish through cross section, but decidedly thicker than other large-seeded sorts, generally well rounded at ends, usually larger at one end than at other, incurved at eye, very distinctly veined, white with slight greenish tinge.

Comparison.—Except for being grown extensively in parts of New Jersey, this variety is little known or planted throughout the country. Its value lies in the large size of its seed, which average larger than those of any other variety. Its pods are peculiar for their great width and curved shape, but are few seeded and short in length, the size of seeds seemingly being attained at expense of size of pods and number of seeds. Most like Large White Pole Lima, differing principally in greater width, thickness, and curvature of pod, and larger, fewer seeds.

History.—Listed by Johnson & Stokes at least since 1882, and apparently introduced by them. Said to have originated in Salem County, N. J.

Illustrations.—Seeds and cross section of pod are similar to Large White Pole Lima (Pl. III, 22, and Pl. V, 31, respectively); and green shell pods to Burpee's Bush Lima (Pl. XXI, 2), differing principally in being much thicker.

SEIBERT'S POLE LIMA.

Listed by 61 seedsmen. Seeds tested: Ferry, 1904, 1906; Fish, 1903; Ford, 1904; Gregory, 1897; Johnson & Stokes, 1902, 1904; Livingston, 1904, 1905.

Description.—Vine of large growth, of good climbing habit, much branched, thick stemmed, green throughout, early, heavily productive, long in bearing. Seed very large, dark green. Flowers white. Green shell pods dark green, moderately curved, flat, inclined to curl and twist from side to side, uniform in size, wide, large-medium, about 4¼ inches long, and usually containing 3 or 4 seeds somewhat separated in pod.

Point or spur of pod absent or insignificant. Quality of green shell beans excellent. Dry seeds very large, almost as broad as long, very flattish through cross section, generally well rounded at ends, generally larger at one end than at other, incurved at eye, very distinctly veined, white with slight greenish tinge.

Comparison.—A well-known standard variety and one of the six most largely grown pole Limas. Larger seeded and possibly sometimes more productive than Leviathan Pole, but pods not nearly as large, straight, handsome, or as early in season. Next to Leviathan it is the best of the extra early large-seeded sorts. Most like Extra Early Jersey Lima, differing principally in earlier season and larger, wider pods often twisted from side to side.

History.—Introduced in 1895 by D. M. Ferry & Co. and originated in Ohio by a Mr. Seibert.

Illustrations.—Green shell pods are illustrated on Plate XXI, 3; seeds and cross section of pod are similar to Large White Pole Lima (Pl. III, 22, and Pl. V, 31, respectively).

SMALL WHITE POLE LIMA.

Listed by 43 seedsmen. Seeds tested: Burpee, 1900; Ferry, 1906; Fish, 1903; Rice, 1905; Thorburn, 1905.

Description.—Vine of large-medium growth, of good climbing habit, much branched, somewhat slender stemmed for a Lima, green throughout, very early, moderately to heavily productive, long in bearing. Leaf small, very dark green, very smooth, very glossy, very stiff, moderately wide across leaflets. Very floriferous. Flowers white. Green shell pods of a rich, dark green color, of very smooth surface, straight, very flat, very uniform in size, moderately wide, very small, about 3 inches long, and usually containing 3 or 4 seeds decidedly separated in pods. Point or spur of pod very small or almost absent. Pods borne on large, numerous clusters. Quality of green shell beans fair to good. Dry seeds small for a Lima, almost as broad as long, decidedly flat through cross section, rounded or slightly truncate at ends, larger at one end than at other, almost straight at eye, very distinctly veined, of a solid creamy white color.

Comparison.—One of the most largely grown pole Limas. Extensively planted in the South, where all the stiff glossy-leaved types succeed best. As sure a cropper as any other pole variety, ranking among pole Limas where Henderson's Bush does among the bush sorts. Where small pods and seeds are objectionable, it will generally be found that Wood's Improved Pole is more satisfactory than this variety. Most like Wood's Improved Pole Lima, differing principally in earlier season, smaller vine and pod, and almost total absence of curled or twisted pods. Pods same as Henderson's Bush Lima except larger.

Synonyms.—Adam's Everbearing Cluster Butter Pole Lima, Carolina Pole Lima, Carolina Sewee Pole Lima, Frost Pole Lima, Saba Pole Lima, Sewee Pole Lima, Sieva Pole Lima, Small Carolina Pole Lima.

History.—Name has been in use in this country at least since 1830 and the type was one of the first cultivated Limas. Known at various times as Frost, Carolina, Sieva, Sewee, Saba, Sivy, Civet, Sky, West Indian, Butter Beans, and Bushel Beans.

Illustrations.—Dry seeds, cross section of pod, green shell pods, and leaf are illustrated on Plate IV, 27, Plate V, 34, Plate XXI, 5, and Plate XXIV, 5, respectively.

WILLOW-LEAVED POLE LIMA.

Listed by 6 seedsmen. Seeds tested: Hastings, 1904; Johnson & Stokes, 1897; Rice, 1905; Schwill, 1905; Steckler, 1904.

Description.—Vine of medium growth, of good climbing habit, much branched, slender stemmed for a Lima, green throughout, very early, moderately productive, long in bearing. Leaf of medium size, very dark green, very smooth, very stiff, very

glossy, and of very long, extremely narrow, pointed leaflets, but leaf type not well fixed in shape, the leaflets often being quite wide and approaching in shape those of Small White Pole Lima. Very floriferous. Flowers white. Green shell pods of a rich, dark green color, of very smooth surface, straight, very flat, very uniform in size, moderately wide, very small, about 3¼ inches long, and usually containing 3 to 4 seeds decidedly separated in pod. Point or spur of rod very small or absent. Pods borne on large numerous clusters. Quality of green shell beans fair to good. Dry seeds large, nearly as broad as long, decidedly flat through cross section, rounded or slightly truncate at ends, larger at one end than at other, almost straight at eye, very distinctly veined, of a solid creamy white color.

Comparison.—Little known and planted. Cultivated mostly in the South. Interesting on account of the peculiar shape of its leaves, but apparently of no superior value or at least generally less productive and hardy than Small White Pole Lima, from which it differs in appearance principally in shape of leaves, decidedly smaller vine, and slightly longer and proportionally narrower pod, which are same as those of Willow-Leaved Bush Lima except larger.

Synonym.—Southern Willow-Leaved Sewee Pole Lima.

History.—Introduced in 1891 by W. Atlee Burpee & Co.

Illustrations.—A leaf is illustrated on Plate XXIII, 2; seeds are similar to Small White Pole Lima (Pl. IV, 27), as also are the green shell pods (Pl. XXI, 5).

WOOD'S IMPROVED POLE LIMA.

Listed by 1 seedsman. Seeds tested: Wood, 1904–1906.

Description.—Vine of large growth, of good climbing habit, much branched, slender stemmed for a Lima, green throughout, early, heavily productive, long in bearing. Leaf small-medium, very dark green, very smooth, very glossy, very stiff, moderately wide across leaflets. Very floriferous. Flowers white. Green shell pods of a rich, dark green color, of very smooth surface, straight, very flat, often inclined to curl from side to side, very uniform in size, moderately wide, very small, about 3¾ inches long, and usually containing 3 or 4 seeds much separated in pod. Point or spur of pod very small or almost absent. Pods borne on large, numerous clusters. Quality of green shell beans fair to good. Dry seed small-medium in size for a Lima, almost as broad as long, very flat through cross section, rounded or slightly truncate at ends, larger at one end than at other, almost straight at eye, very distinctly veined, of a solid creamy white color.

Comparison.—Little known and planted. The best of the small-seeded pole Limas, possessing not only all the good qualities of the small-seeded sorts, but superior in being larger podded, more vigorous, and productive. Most like Small White Lima, differing principally in larger, straighter pods having a tendency to curl from side to side. Pods same as Wood's Prolific Bush except smaller.

Synonyms.—King's Improved Pole Lima, Nichol's Medium Butter Pole Lima.

History.—Introduced by T. W. Wood & Sons, by whom it has been listed at least since 1893.

Illustrations.—Dry seeds, green shell pods, and cross section of same are illustrated on Plate IV, 26, Plate XXI, 4, and Plate V, 35; leaf is similar to White Pole Lima (Pl. XXIV, 5).

KIDNEY BEANS (PHASEOLUS VULGARIS.)

This species, which is the common cultivated bean of all the North and South American countries, is represented by more distinct varieties than any other species cultivated in American gardens. It is com-

monly divided into green-podded bush, wax-podded bush, green-podded pole, and wax-podded pole varieties.

BUSH GREEN-PODDED.

This is the most important class of the Kidney beans and the only one which is grown to any extent as a field crop. Being so largely cultivated for its dry seed, the class naturally contains more tough-podded varieties than the wax-podded class, though many of the varieties are fully as good in quality and, taken as a whole, the varieties are even more extensively used as snaps than are the wax-podded kinds.

BEST OF ALL BUSH.

Listed by 43 seedsmen. Seeds tested: Burpee, 1897; Ferry, 1900; Keeney, 1904–1906; Rice, 1905, 1906; Steckler, 1904, 1905; Thorburn, 1901, 1902.

Description of late or true type.—Plant large, spreading extensively over ground, with heavy, thick-stemmed, drooping branches, without real runners, wholly green, very late, long in bearing, heavily to moderately productive. Leaf very large, dark green, wide across leaflets, and of very rough surface. Flowers light pink. Snap pods somewhat variable in size, very long, straight, oval-round through cross section, often twisted or bent, medium green, brittle, stringy, of small fiber, of good quality, fairly free from anthracnose. Point of pod short and either slightly curved or straight. Green shell pods borne mostly below foliage, sometimes sparingly splashed with light red, fairly full on outside between seeds, rarely with undeveloped seeds, generally regular in shape, about 7⅛ inches long, and usually containing 6 to 8 seeds crowded in pod. Dry pods easy to thrash. Dry seeds medium in size and length, roundish oval through cross section, rounded or truncate at ends, nearly straight at eye, of pale buff color, freely splashed with purplish red.

Description of early or flat-podded type.—Plant large, slightly spreading, with occasional outstretched branches but without real runners, thick stemmed, wholly green, intermediate in season, of moderate bearing period, heavily to moderately productive. Leaf large, dark green, wide across leaflets, and of rough surface. Flowers light pink. Snap pods varying greatly in size, long-medium, slightly curved, flat, medium green, tough, very stringy, of much fiber, poor in quality, free from anthracnose. Point of pod small and either straight or slightly curved. Green shell pods borne both above and below foliage, moderately splashed with light red, much depressed between seeds, often containing undeveloped seeds, frequently imperfect in shape, about 5½ inches long, and usually containing 3 to 6 seeds somewhat separated in pod. Dry pods easy to thrash. Dry seeds medium in size and length, oval through cross section, rounded at ends, straight at eye, pale buff freely splashed with purplish red.

Comparison of late and early types.—Well known, but not one of the twenty most largely grown bush sorts. Formerly a great favorite in New Orleans and other southern markets. Most stocks of present day are badly mixed, the true fleshy-podded type having degenerated into a smaller, flatter podded bean, somewhat resembling a short imperfect Mohawk, but so tough as to be of little value for snaps and so unattractive as to be quite unsalable for green shell beans. The original fleshy-podded type is one of the longest and most showy of the bush varieties and excellent as snaps and green shell beans for either home or market, but not as reliable or as generally useful as Byer's Bush or Refugee. Very similar to Giant Forcer, differing in no important respect except in color of seed, while it differs from Longfellow principally in thicker, longer, more curved, shorter pod point, and in having seeds of different color and shape.

Synonyms of late type.—Breck's String and Shell, Sion House Forcing, Sutton's Dwarf Forcing.

Synonyms of early type.—Earliest Green Pod, Isbell's Earliest, Shipper's Favorite.

History.—Originated in Germany, and first listed in this country about 1876.

Illustrations.—Dry seeds of late type are shown on Plate I, 17; those of early type on Plate I, 18; snap pods of late type on Plate XI, 3; green shell pods of early type resemble in shape and size the short pods often found in Boston Favorite (Pl. XIV, 4), differing principally in being smaller and narrower; cross section of snap pod of late type is about as wide as Black Valentine (Pl. V, 14), but much larger in size; cross section of snap pod of early type is similar to Mohawk (Pl. V, 17).

BLACK TURTLE SOUP FIELD.

Listed by 4 seedsmen. Seeds tested: Dreer, 1905; Moore and Simon, 1904.

Description.—Plant very large, very spreading, with low-growing branches and runners of more or less creeping habit, very thick stemmed, and dark purple in color, late in season as snaps and field beans, of very long bearing period, very heavily productive. Leaf large, very dark green, varying to solid dark purple when old, very wide across leaflets, of rough surface. Flowers pink. Snap pods uniform in size, long, slender, curved, flat, dark green, tinged with dark bluish purple, very tough, very stringy, of much fiber, very poor in quality, very free from anthracnose. Point of pod medium in length and slightly curved. Green shell pods borne well below foliage, of coarse surface, varying in color from dark green to solid dark purple, depressed between seeds, about 5⅜ inches long and usually containing 7 to 9 seeds fairly close in pod. Dry pods very easy to thrash. Dry seeds very small, proportionally short, flattish oval through cross section, rounded or truncate at ends, straight or slightly incurved at eye, solid black in color.

Comparison.—Strictly a field variety and grown to a small extent in parts of California and New York for the foreign population and for seaboard use, being especially adapted for latter purpose because of its ability to withstand moisture better than most other sorts. Dry beans are quite different in flavor and quality from other varieties grown in this country and are in some demand for use in making certain kinds of soups. Pods decidedly too tough for snaps, too dull purple in color, too small seeded for green shell beans, and vines too late, coarse-growing, and spreading in habit for general cultivation. Pods similar in color to Blue Pod Butter and in shape more resembling the flat-podded type of Southern Prolific Pole than any bush variety, differing principally in shorter, narrower pods more curved at tip end.

Synonyms.—Black Spanish, Tampico, Turtle Soup.

History.—Cultivated in this country at least since 1845.

Illustrations.—Dry seeds are shown on Plate III, 17; snap pods on Plate XIII, 4; cross section of snap pods is similar to the flat-podded type of Southern Prolific (Pl. V, 2), differing principally in flatter shape.

BLACK VALENTINE.

Listed by 26 seedsmen. Seeds tested: Henderson, 1902; Keeney, 1904–1906; Tait, 1905; Thorburn, 1905.

Description.—Plant large-medium, fairly erect, with occasional drooping branches but without real runners, thick stemmed, green throughout, slightly purplish tinged at nodes of stem and flower branches, early intermediate in season, of moderate bearing period, moderately to heavily productive. Leaf medium in size, narrow across leaflets, medium green in color. Flowers pink. Snap pods very uniform, long, straight, almost round, dark green, tough, very stringy, of much fiber, of poor quality, fairly free from anthracnose. Point of pod long, slightly curved. Green shell pods

generally borne well above foliage, never colored or splashed, full on outside between seeds, about 6 inches long and usually containing 6 seeds crowded in pod. Dry pods easy to thrash. Dry seed small-medium, proportionally long, roundish oval through cross section, rounded or truncate at ends, straight at eye, solid black in color.

Comparison.—Extensively grown by market gardeners in parts of the South but not one of the twelve most largely grown varieties of the United States. Being unsurpassed in hardiness, excellent for shipping, and one of the most uniformly productive, reliable, and handsome podded varieties, it is often the most profitable bean for market gardeners but because of being exceedingly tough and stringy it never gives satisfaction to the consumer; and here in America, where snaps are gathered so much later than is customary in Europe, the use of varieties such as these for snaps should be discouraged by seedsmen. Because of small black seed and narrow pods, it is also undesirable for green shell beans. Most like Longfellow, differing principally in color of seed and tougher, flatter, more perfectly formed pods. Similar to Red Valentine only in earliness and shape of leaves.

Synonym.—King of Earlies.

Confusing names.—Brown-Speckled Valentine, Cream Valentine, Giant Valentine, Red Valentine, White Valentine, all of which are very different from Black Valentine.

History.—Present type is claimed to have come from Europe and to have been first introduced in 1897 by Peter Henderson & Co., although it has not yet been proved that it is different from the Black Valentine listed about 1850 and afterwards dropped by American seedsmen.

Illustrations.—Dry seeds are shown on Plate III, 20; snap pods on Plate IX, 4, and a cross section of snap pod is shown on Plate V, 14.

BLUE POD BUTTER.

Listed by 3 seedsmen. Seeds tested: Burpee, 1901, 1902, 1905; Rogers, 1904.

Description.—Plant medium in size, erect, without runners or spreading branches, thick stemmed, more or less purplish tinged, especially at nodes and flower stems, early-intermediate in season, of short bearing period, lightly productive. Leaf medium in size, dark green, varying to solid dull bluish purple, very wide across leaflets, and of slightly rough surface. Flowers purple. Snap pods uniform in size, long, straight, flat, dark green, varyingly tinged with bluish purple, somewhat tough, stringy, of moderate fiber, of poor to medium quality, fairly free from anthracnose. Point of pod long and straight or slightly curved. Green shell pods borne both above and below foliage, generally solid bluish purple in color, somewhat depressed between seeds, about 6⅞ inches long and usually containing 6 or 7 seeds, somewhat separated in pod. Dry pods easy to thrash. Dry seeds of medium size, proportionally long, flattish oval through cross section, truncate or rounded at ends, generally slightly incurved at eye, solid light ecru in color with minute brownish area around eye.

Confusing name.—Blue Pod Field, which is of a very different type from Blue Pod Butter.

Comparison.—Little known or planted and grown only by amateurs, to whom it is interesting because of its peculiar blue color. Often thought to be of good quality, but really quite tough and full of fiber, and being also unproductive and too dull purple in color for market use it possesses no real practical value. Habit of vine about same as Davis Wax and pods similar in size and shape to Allan's Imperial Wax.

History.—Introduced in 1888 by W. Atlee Burpee & Co., who state that the variety came from Germany.

Illustrations.—Dry seeds are shown on Plate III, 15; snap pods on Plate XI, 4; leaf on Plate XXIV, 4; cross section of snap pod is similar to Detroit Wax (Pl. V, 16), differing principally in being larger.

BOSTON FAVORITE.

Listed by 30 seedsmen. Seeds tested: Gregory, 1905; Rogers, 1904.

Description.—Plant very large, very spreading with moderate number of runners, thick stemmed, green throughout, late-intermediate in season, long to moderate in bearing period, heavily productive. Leaf medium in size, medium green in color; flowers light pink, snap pods varying greatly in size and shape, generally long, occasionally short, slightly curved, flat, medium green, tough, stringy, of much fiber, of poor quality, very free from anthracnose. Point of pod medium in length and either straight or slightly curved. Green shell pods borne mostly below foliage, abundantly splashed with brilliant red, much depressed on outside between seeds, about 6⅝ inches long and usually containing 5 or 6 seeds somewhat separated in pod. Dry pods easy to thrash. Dry seeds large, very long, oval through cross section, invariably much rounded at ends, generally straight at eye, pale buff in color freely splashed with purplish red.

Comparison.—Largely planted in all parts of the United States, especially in New England, but not one of the twelve most largely grown bush sorts. Too tough and stringy for snaps and suitable only for green shell beans, though on account of the large proportion of undersized and imperfect pods it is much inferior for this use to Improved Goddard which it closely resembles, differing principally in more spreading habit, later season, and smaller, more unevenly shaped pods.

Synonyms.—Breck's Dwarf Horticultural, Goddard.

History.—Introduced in 1885 by the former Aaron Low Seed Company.

Illustrations.—Dry seeds are shown on Plate I, 26; green shell pods on Plate XIV, 4.

BOUNTIFUL.

Listed by 31 seedsmen. Seeds tested: Henderson, 1900–1902, 1905; Keeney, 1904–1906; Rogers, 1906.

Description.—Plant large-medium, fairly erect when young, but often drooping when fully grown, without runners or decided spreading branches, somewhat thick stemmed, green throughout, very early, of moderate bearing period, heavily to moderately productive. Leaf medium in size, very light green in color. Flowers light pink. Snap pods uniform in size, very long, generally curved only at tip end, flat, very light green in color, brittle, stringless, of inappreciable fiber, of good quality, somewhat subject to anthracnose. Point of pod extremely long, slender, and slightly curved or straight. Green shell pods borne both above and below foliage, never colored or splashed, slightly depressed between seeds, about 6¾ inches long and usually containing 6 to 8 seeds fairly close in pod. Dry pods generally easy to thrash. Dry seeds medium in size, slender, roundish oval through cross section, truncate or rounded at ends, straight or slightly incurved at eye, solid straw yellow in color, sometimes shading to coppery yellow, always with minute brownish area around eye.

Comparison.—Well known but not one of the twelve most largely grown bush varieties. Rapidly gaining in popularity and largely replacing Long Yellow Six Weeks, to which it is much superior in quality, besides earlier and having larger, straighter pods. Because of fine quality, it makes an excellent sort for home gardening, and being, with the possible exception of Grenell's Stringless Green Pod and Hodson Green Pod, the largest, most handsome, and even shaped of the flat, green-podded bush sorts, is excellent also for market use. Of same usefulness as Grenell's Stringless Green Pod and more like it in appearance than any other, differing in no important respects except in color of seed, in season, and in light green foliage.

Synonyms.—Breck's Boston Snap, Sutton's Plentiful (of English seed houses).

History.—Introduced in 1899 by Peter Henderson & Co., who state the variety came from D. G. Burlingame, of Genesee, N. Y.

Illustrations.—Snap pods and cross section of same are shown on Plate XIII, 1, and Plate V, 9, respectively; new and old seed are same color, shape, and size as Long Yellow Six Weeks (Pl. III, 18).

BROWN SWEDISH FIELD.

Listed by 2 seedsmen. Seeds tested: Isbell, 1905; Northrup, King, & Co.,,1905, 1906.

Description of round-podded type.—Plant large-medium in size, very erect, without runners or spreading branches, somewhat thick stemmed, green throughout, intermediate in season as snaps, early as field beans, long in bearing period, heavily productive. Leaf medium in size, medium green in color. Flowers light pink. Snap pods uniform in size, short-medium, straight, oval-flat through cross section, becoming round at green shell stage, light green, very tough, very stringy, of much fiber, poor in quality, free from anthracnose. Point of pod short and slightly curved. Green shell pods borne both above and below foliage, never colored or splashed, much depressed between seeds, about $5\frac{3}{8}$ inches long, and usually containing 5 or 6 seeds crowded in pod. Dry pods easy to thrash. Dry seeds of medium size, proportionally short, roundish through cross section, truncate or rounded at ends, generally larger at one end than at other, rounded or flat at eye, solid brownish ocher in color except minute brownish area around eye.

Description of flat-podded type.—This type is larger in vine, a little later in season, often inclined to spread and send out runnerlike branches, and with pods and seeds much larger and flatter than above type.

Comparison of round and flat podded types.—This name is somewhat loosely applied to a number of brown-colored beans brought over to this country by Swedish immigrants and grown to a limited extent in the Northwest, where there is a demand for them among the foreign population. All are strictly dry shell varieties and too tough and stringy for good snaps, while as green shell beans they are too small seeded and too narrow podded to compare well with such green shell varieties as Improved Goddard. The round-podded type here described is most like China Red Eye, differing principally in color and shape of seed and in shorter, straighter, more oval pods, while the flat-podded type is most like Long Yellow Six Weeks, differing principally in color of seed, in smaller, narrower pods, and in larger, more spreading vines.

History.—Name appears to have been first recognized in seed catalogues about 1890 by Northrup, King & Co., although probably in use among produce trade some time before this date.

Illustrations of round-podded type.—Dry seeds are shown on Plate II, 3; snap pods are of similar shape to Round Yellow Six Weeks (Pl. XIII, 5), differing principally in being flatter and with seeds less crowded in pod.

Illustrations of flat-podded type.—Dry seeds are same in color as the round-podded type described above and similar in shape to Long Yellow Six Weeks (Pl. III, 18); snap pods are also similar in shape to Long Yellow Six Weeks (Pl. X, 1), differing principally in being narrower and shorter; cross sections of snap pods are similar to Mohawk (Pl. V, 17), differing principally in smaller and flatter shape.

BURPEE'S STRINGLESS GREEN POD.

Listed by 156 seedmen. Seeds tested: F. W. Bolgiano, 1903; Burpee, 1897, 1899–1902, 1906; Dibble, 1905; Ferry, 1902; Keeney, 1904–1906; Philipps, 1903; Rogers, 1904; Thorburn, 1901, 1902; Vaughan, 1903.

Description.—Plant large-medium, very erect when young, with a few shoots high above plant, but more or less drooping or spreading when fully grown; without runners, thick stemmed, green throughout, early, of moderate bearing period, heavily to moderately productive. Leaf medium in size, medium green in color. Flowers

light pink. Snap pods somewhat variable in size, long, generally more or less scimiter curved, sharply constricted between seeds as though drawn tight by a thread and separated into sections, round, dark green, extremely brittle, absolutely stringless, without fiber, of very good quality, somewhat subject to anthracnose. Point of pod medium in length, variable in shape, and either straight, curled, or twisted. Green shell pods borne mostly above foliage, never appreciably colored or splashed, very much depressed between seeds, about 5 inches long, and usually containing 6 seeds very crowded in pod. Dry pods hard to thrash. Dry seeds medium in size and length, roundish through cross section, truncate or rounded at ends, straight at eye, sliver from pod occasionally attached to eye, solid burnt umber in color.

Comparison.—One of the five most largely planted green-podded varieties and popular because of general reliability, hardiness, productiveness, and tenderness; also unsurpassed for home use, adapted to all sections of the country, and though largely grown by market gardeners it is not always regular enough in shape to make a good appearance on the market, generally containing a larger percentage of imperfect pods than Red Valentine, Extra Early Refugee, and most others of its class. Some complaint also has been made within the last three years of its susceptibility to rust and anthracnose. Similar to Giant Stringless Green Pod, Henderson's Full Measure, and Knickerbocker, differing principally from the first-named sort in color of seed, a few days earlier season, shorter, thicker, and more curved pods, and shallower constrictions between seeds.

Synonyms.—Bell's Prolific Green Pod, McKenzie's Matchless Green Pod, Muzzy's Stringless Green Pod.

Confusing names.—Grenell's Stringless Green Pod, Giant Stringless Green Pod, Jones's Stringless Green Pod, all of which are very different from Burpee's Stringless Green Pod.

History.—Introduced in 1894 by W. Atlee Burpee & Co., and originated by N. B. Keeney & Son, of Leroy, N. Y.

Illustrations.—Snap pods and cross section are shown on Plate IX, 3, and Plate V, 13, respectively.

BYER'S BUSH.

Listed by 1 seedsman. Seeds tested: Childs, 1904, 1905; Thorburn, 1901, 1902.

Description.—Plant large, very erect when young, but somewhat drooping when fully developed, somewhat thick stemmed, green throughout, late, of long bearing period, heavily productive. Leaf medium in size, medium green in color, narrow across leaflets, of smooth and remarkably glossy surface, of very long petiole. Flowers pink. Snap pods uniform in size, long, very straight, round, medium green, of exceedingly smooth and glossy surface, extremely brittle, stringy, of inappreciable fiber, of good quality, fairly free from anthracnose. Point of pod very long and curved. Green shell pods borne both above and below foliage, sparingly purplish splashed, full on outside between seeds, about 5¾ inches long, and usually containing 5 or 6 seeds crowded in pod. Dry pods generally easy to thrash. Dry seeds of medium size, slender, roundish through cross section, straight at eye, truncate or rounded at ends, chiefly solid violet-purple, but always more or less splashed and mottled with pale buff.

Comparison.—Little known or planted, but one of the most hardy and productive of snap beans, producing remarkably uniform, straight, handsome pods of beautiful glossy green color, far surpassing Red Valentine and Burpee's Stringless Green Pod in all these respects and being almost as productive as Refugee. Too late in season to be suitable for some uses and not quite free enough from fiber to make the best snaps. Market gardeners are advised to give the variety a trial, as it may in some cases prove more profitable with them than Refugee or other late sorts. More like Giant

Stringless Green Pod than any other, differing principally in more regularly shaped pods without deep depressions between seeds, without imperfectly defined ends, and in peculiar glossy green color.

History.—Apparently first listed in 1899 by John Lewis Childs, who writes that the seed was obtained from a Mr. Byer, of Tennessee.

Illustrations.—Snap pods are shown on Plate XII, 1; dry seeds are indistinguishable from Refugee (Pl. III, 5); cross sections of snap pods are similar to Burpee's Stringless Green Pod (Pl. V, 13).

CANADIAN WONDER.

Listed by 21 seedsmen. Seeds tested: Bridgeman, 1901; Cox, 1902; Fish, 1903; Kendel, 1901; Sharpe, 1904; Simmers, 1905; Thorburn, 1905; Tilton, 1901.

Description.—Plant very large, very erect, without runners or spreading branches, thick stemmed, green throughout, very late, long in bearing, very heavily productive. Leaf large, dark green, and of somewhat rough surface. Flowers light pink. Snap pods somewhat variable in size, very long, curved, flat, of very rough, coarse surface, dark green, very tough, very stringy, of much fiber, of poor quality, very free from anthracnose. Point of pod long and slightly curved. Green shell pods borne both above and below foliage, never appreciably colored or splashed, depressed on outside between seeds, about $8\frac{1}{8}$ inches long and usually containing 6 to 8 seeds somewhat separated in pod. Dry pods easy to thrash. Dry seeds large, long, very flattish oval through cross section, rounded or truncate at ends, straight or incurved at eye, solid plum-violet in color.

Comparison.—A well known but not extensively planted variety. Used both as a field and garden bean and, with the possible exception of Prolific Pickler, the longest podded, largest in growth of vine, and one of the most showy of the bush sorts for exhibition purposes. If picked very early the young pods are not only suitable as snaps but are as large in size as most sorts are when picked at the customary stage, but unless picked extremely early the pods will be fully as tough and as unsuitable for snaps as most field varieties. Excellent as green shell beans. More like Prolific Pickler than any other and next most like Red Kidney, differing principally in longer pod, later season, and larger vine.

Synonym.—Rose.

History.—Of uncertain origin and introduction. Listed by American seedsmen at least since 1884, when it was known as Rose Bean.

Illustrations.—Dry seeds are shown on Plate III, 27; snap pods on Plate X, 2; leaf on Plate XXIV, 6.

CHINA RED EYE.

Listed by 43 seedsmen. Seeds tested: Buckbee, 1897; Burpee, 1897, 1901; Keeney, 1904–1906; Thorburn, 1897, 1901.

Description.—Plant medium in size, very erect, without runners or spreading branches, somewhat slender stemmed, green throughout, early, of moderate bearing period, heavily to moderately productive. Leaf medium in size, light green in color. Flowers white. Snap pods very uniform in size, medium in length, straight, oval through cross section, light green in color, tough, very stringy, of much fiber, of poor quality fairly free from anthracnose. Point of pod small-medium and straight. Green shell pods borne both above and below foliage, never appreciably splashed or colored, depressed between seeds, about $5\frac{1}{2}$ inches long, and usually containing 5 or 6 seeds crowded in pod. Dry pods easy to thrash. Dry seeds medium in size and length, roundish oval through cross section, rounded or truncate at ends, invariably straight at eye, white at sides and back and dark purplish red with pale buff marking around eye and ends.

Comparison.—A standard variety of the United States, but not one of the twelve most largely grown bush sorts. Formerly one of the principal garden varieties, but now largely replaced by better sorts. Decidedly too tough podded for good snaps, but on account of hardiness, reliability, and uniform, attractive pods it is still grown in some sections both for snaps and green shell beans. General usefulness and value about the same as Mohawk, Long Yellow Six Weeks, and Improved Yellow Eye, while in appearance of pod it is most like Round Yellow Six Weeks and Improved Yellow Eye, differing from the former principally in color and shape of seed, and longer, slenderer pods, which are quite stringy.

History.—One of the oldest of existing American sorts and cultivated in this country at least since 1800.

Illustrations.—Dry seeds are shown on Plate I, 15, and snap pods on Plate XI, 2.

CREAM VALENTINE.

Listed by 1 seedsman. Seeds tested: Henderson 1897, 1902, 1903, 1905.

Description.—Plant medium in size, very erect, without runners or spreading branches, somewhat slender stemmed, green throughout, early, of moderate bearing period, moderately productive. Leaf medium in size, medium green in color, and very narrow across leaflets. Flowers white. Snap pods uniform in size, of medium length, curved, round-broad through cross section, deeply creasebacked, medium green, extremely brittle, stringy, of inappreciable fiber, of good quality, fairly free from anthracnose. Point of pod long and slightly curved. Green shell pods borne extremely high on plant and mostly above foliage, never splashed or colored, somewhat depressed on outside between seeds, about 4¾ inches long and usually containing 5 or 6 seeds very crowded in pod. Dry pods hard to thrash. Dry seeds medium in size, slender, roundish through cross section, decidedly truncate at ends, straight at eye, irregular in shape, twisted, depressed or bulged out in places, solid medium ecru in color, with minute brownish yellow area around eye.

Comparison.—Little planted and unimportant. Differs from Red Valentine only in color of seed and less in being productive.

Confusing names.—Black Valentine, Brown Speckled Valentine, Giant Valentine, Red Valentine, White Valentine, all of which are very different from Cream Valentine.

History.—Introduced in 1897 by Peter Henderson & Co., who write that the variety originated in Genesee County, N. Y.

Illustrations.—Seeds are shown on Plate III, 14; snap pods are same as represented for Red Valentine (Pl. VII, 3); cross sections of snap pods are similar to Burpee's Stringless Green Pod (Pl. V, 13); differing principally in smaller size and broader shape.

CRIMSON BEAUTY.

Listed by 1 seedsman. Seeds tested: Ford, 1904, 1905.

Description.—Plant large, very erect, with long stem holding plant well up from ground, without runners or spreading branches, thick stemmed, green throughout, early-intermediate in season, long to moderate in bearing period, heavily to moderately productive. Leaf medium in size, medium green in color. Flowers light pink. Snap pods very uniform in size, long, very straight, flat, dark green, of much fiber, tough, very stringy, of poor quality, free from anthracnose. Point of pod medium in length and slightly curved. Green shell pods borne both above and below foliage, abundantly splashed with brilliant red, moderately depressed between seeds, about 6⅝ inches long and usually containing 6 seeds fairly close in pod. Dry pods easy to thrash. Dry seeds large, oval through cross section, generally well rounded at ends, generally straight at eye, pale buff in color, freely splashed with purplish red.

Comparison.—Little known and planted, and although a good green shell bean of similar value and usefulness to Improved Goddard it is inferior to that variety in size of pods and productiveness of plants, but because of much earlier season it may sometimes be more useful to market gardeners. The variety may be aptly called an "Extra Early Improved Goddard."

History.—Introduced in 1896 by Ford Seed Company, who write that the variety originated with E. D. Gibson, of Ashburnham, Mass., and that it is a cross between Dwarf Horticultural and a wax variety.

Illustrations.—Dry seeds are shown on Plate I, 28; green shell pods are similar to Improved Goddard (Pl. XIV, 3), differing principally in smaller size and averaging straighter or at least rarely curved back at stem end as is common in Improved Goddard; cross sections of snap pods are similar to Mohawk (Pl. V, 17), differing principally in larger size and flatter shape.

DAY'S LEAFLESS MEDIUM FIELD.

Listed by 7 seedsmen. Seeds tested: Johnson & Stokes, 1897.

Description.—Plant very large, very spreading, of many runners, slender stemmed, green throughout, late as snaps and field beans, long in bearing period, very heavily productive. Leaf small, medium green. Flowers white. Snap pods uniform in size, short, generally much curved back at stem end, very flat, changing to oval at green shell stage, very square at tip, very light green, very tough, very stringy, of much fiber, of very poor quality, very free from anthracnose. Point of pod short and straight. Green shell pods borne mostly below foliage, never splashed or colored, depressed between seeds on outside of pod, about $4\frac{3}{8}$ inches long, and usually containing 6 or 7 seeds crowded in pod. Dry pods very easy to thrash. Dry seeds small, short, roundish oval through cross section, rounded or slightly truncate at ends, full or rounded at eye, solid white.

Comparison.—Strictly a field variety and wholly unsuited for use as snaps or green shell beans. Seeds intermediate in size between the large seeds known to produce trade as marrows and the small seeds known as pea beans. Generally known in the wholesale markets as mediums.

History.—First listed by seedsmen about 1898 and said to have originated with N. H. Day, of Honeoye Falls, N. Y.

Illustrations.—Dry seeds are shown on Plate IV, 6; green shell pods and cross sections resemble Navy Pea (Pl. XIII, 3, and Pl. V, 3, respectively), differing principally in being much more curved back at stem end, much flatter, and much larger.

EARLIEST MARKET.

Listed by 1 seedsman. Seeds tested: Griffith & Turner, 1905, 1906.

Description.—Plant large, very spreading, with moderate number of runners and drooping branches, somewhat thick stemmed, green throughout, early-intermediate in season, long in bearing, lightly to moderately productive. Leaf medium in size, dark green in color, of smooth and glossy surface. Flowers white. Snap pods variable in size, very long, slightly curved, very flat, medium green, tough, stringy, of much tough fiber, of poor to medium quality, free from anthracnose. Point of pod moderately long and curved. Green shell pods borne in large clusters well above foliage, never splashed or appreciably colored, much depressed between seeds, about $6\frac{3}{4}$ inches long and usually containing 6 or 7 seeds well separated in pod. Dry pods very easy to thrash. Dry seeds large-medium, proportionally short, flattish through cross section, generally well rounded at ends, straight or incurved at eye, generally regular in shape, but sometimes slightly bulged out in places, solid white.

Comparison.—Little known and planted. Most successful at the South. Profitable only for green shell beans, its pods being too flat, tough, and unattractive for use

as snaps, and although its white seeds are very desirable for baking as well as for green shell, still it has never been found profitable as a field bean. Its superior merits, if any, are earliness and large size of seed, being similar in the former respect to Emperor William, but not nearly as large seeded nor producing such uniformly large, wide, handsome pods, besides having smaller, more spreading vine, smaller leaves, more runners, and more fruit spurs projecting high above plant. Next to Emperor William the variety is most like Tennessee Green Pod in appearance as well as in general usefulness and value.

Synonym.—Schwill's Quick Crop.

History.—Named in 1895 by Griffith & Turner, by whom it was formerly listed as First in Market. Probably same as Landreth's First in Market, introduced in 1883 by D. Landreth & Sons.

Illustrations.—Dry seeds are similar to Emperor William (Pl. IV, 19); green shell pods and cross section of snap pods resemble Dutch Case Knife Pole (Pl. XX, 1 and Pl. V, 28, respectively), differing principally in smaller and narrower shape.

EARLY AROOSTOOK FIELD.

Listed by 1 seedsman. Seeds tested: Jerrard, 1905, 1906.

Description.—Plant medium in size, erect, generally without runners or spreading branches, somewhat thick stemmed, early as snaps and field beans, of short bearing period, heavily to moderately productive. Leaf medium in size, medium green in color. Flowers white. Snap pods very uniform in size, long-medium, curved at middle, flat, light green, tough, very stringy, of much fiber, of poor quality, free from anthracnose. Point of pod long and curved. Green shell pods borne both above and below foliage, never colored or splashed, depressed on outside between seeds, about $5\frac{3}{4}$ inches long, and usually containing 6 seeds fairly close in pods. Dry pods very easy to thrash. Dry seeds medium in size, roundish through cross section, slender, truncate or rounded at ends, generally slightly incurved at eye, solid white.

Comparison.—Little known or planted, but claimed to be valuable as an extra early, white-seeded field bean for northern latitudes like Aroostook County, Me., where the seasons are short for growing late varieties of field beans. Fairly productive, hardy, and possibly a good sort for southern latitudes, but too tough podded to be generally recommended for snaps and not equal as green shell beans to most garden varieties nor to large-seeded field sorts, such as White Kidney and Canadian Wonder. Most like Long Yellow Six Weeks, differing principally in color and smaller size of seed, earlier season, and smaller, narrower pods.

Confusing name.—Aroostook Bush Lima, a very different type of bean.

History.—Introduced about 1893 by George W. P. Jerrard Company.

Illustrations.—Dry seeds are shown on Plate IV, 10; snap pods are similar in shape to Long Yellow Six Weeks (Pl. X, 1), differing principally in smaller and narrower shape.

EMPEROR WILLIAM.

Listed by 6 seedsmen. Seeds tested: Burpee, 1901; Holmes, 1905; Mitchell, 1905, 1906; Rawson, 1902; Wernich, 1905.

Description.—Plant large, spreading, very low growing in habit, with many outstretched branches and occasional runners, green throughout, thick stemmed, intermediate in season, long in bearing, moderately productive. Leaf large, dark green, wide across leaflets, and of very rough surface. Flowers white. Snap pods somewhat variable in size, very long, slightly curved, very flat, light green, somewhat tough, stringy, of much fiber, poor to medium in quality, free from anthracnose. Point of pod moderately curved and long. Green shell pods borne in large, numerous clusters high above foliage, never appreciably colored or splashed except for black lines along

sutures, much depressed on outside between seeds, about 6¾ inches long and usually containing 6 or 7 seeds much separated in pod. Dry pods very easy to thrash. Dry seeds large-medium, proportionally short, flattish through cross section, rounded at ends, straight or incurved at eye, generally regular in shape, but sometimes slightly bulging out in places, solid white except an occasional minute area of faint yellow around eye.

Comparison.—A favorite in Europe and advertised in this country for a long time, but never very popular. Its large white seeds are much liked by some gardeners for green shell beans, but it seems to have never become generally cultivated in America because spreading in habit and too tough, flat podded, and unattractive as snaps. White Kidney is far more profitable for dry beans, and is generally more satisfactory for green shell beans also. Most like Earliest Market in appearance and general usefulness, and next most like Tennessee Green Pod.

Synonyms.—Dwarf Case Knife, First in Market.

History.—First listed in this country about 1880 and described at that time as a new German variety.

Illustrations.—Dry seeds are shown on Plate IV, 19; green shell pods and cross section of snap pods are similar to Dutch Case Knife Pole (Pl. XX, 1, and Pl. V, 28, respectively), differing principally in smaller size.

EUREKA FIELD.

Listed by 1 seedsman. Seeds tested: Ford, 1904, 1905.

Description.—Plant medium in size, erect, with occasional spreading branches, but without real runners, thick stemmed, green throughout, late as snaps, early-intermediate as field beans, of moderate bearing period, lightly to moderately productive. Leaf medium in size, medium green in color. Flowers pinkish white. Snap pods uniform in size, short, slightly curved, very flat, light green, very tough, very stringy, of much fiber, of poor quality, fairly free from anthracnose. Point of pod very short and straight. Green shell pods borne both above and below foliage, never colored or splashed, much depressed between seeds, about 4⅝ inches long, and usually containing 5 or 6 seeds somewhat separated in pod. Dry pods very easy to thrash. Dry seeds small-medium, proportionately short, roundish through cross section, invariably well rounded at ends, decidedly larger at one end than at other, invariably rounded or full at eye, solid light greenish yellow in color.

Comparison.—This little-known and little-planted variety is a strictly green and dry shell bean of no real merit except for the interesting light yellow color of its dry seed. Its pods are decidedly too tough and stringy for good snaps, while for green or dry shell beans the variety is less productive than any other field sort and generally bears a larger percentage of imperfect pods. Most like Vineless Marrow, differing principally in color of seed and smaller pods with peculiar, short, well-defined pod point borne at center end of pod.

Synonyms.—Genter's Sulphur, California Cream Beans, Sulphur-Colored Bean.

History.—Introduced in 1893 by Ford Seed Company, who state the variety came from Mr. Goulding, of Portage County, Ohio, in whose family it has been for a long time, but the type has been doubtless known to many people at least since 1870.

Illustrations.—Dry seeds are shown on Plate I, 2; green shell pods are quite unlike any of following illustrations, but perhaps most resemble Red Kidney (Pl. XIV, 1), differing principally in color of seed, and shorter, better filled, narrower, and more regularly shaped pods with shorter, better defined pod point.

EVERBEARING.

Listed by 1 seedsman. Seeds tested: Burpee, 1900, 1901; Denison, 1903; Thorburn, 1901, 1902, 1905, 1906.

Description.—Plant large, very spreading, low growing, almost creeping in habit, of many runners, thick stemmed, green throughout, very late, very long in bearing, heavily productive. Leaf medium in size, very dark green in color. Flowers white. Snap pods varying greatly in size, long, curved, flat, medium green in color, exceedingly tough and stringy, of much hard fiber, of very poor quality, very free from anthracnose. Point of pod medium in length and either straight or slightly curved. Green shell pods generally borne on numerous thick stems high above foliage, never splashed or appreciably colored, very much depressed on outside between seeds, often vacant seeded, about 5¾ inches long, and usually containing 5 or 6 seeds somewhat separated in pod. Dry pods very easy to thrash. Dry seeds medium in size and length, flattish oval through cross section, mostly well rounded at ends, incurved at eye, solid white.

Comparison.—This very unusual and little planted variety seems to be of but limited value for this country, but in France, where snap pods are gathered very young and undersized, it may be one of the best garden varieties. Its pods consist of almost as much fiber as any variety cultivated in America and are decidedly too tough as snaps for American conditions, while for green shell beans it is too narrow podded, too irregular in shape, and too unattractive for a profitable market variety. Its use, if any, seems to be for dry beans, as its seeds are pure white and its plants productive in right locations. The different stocks seem to vary greatly in size, shape, and season, and principally for this reason it has not been much grown, even for dry beans. Quite different from other American sorts, but perhaps as much like Earliest Market as any, the pods differing principally in being smaller, narrower, more curved, deeper depressed between seeds, and more uneven and ill shaped, while vines are coarser and more spreading, with fruit spurs more numerous and projecting more prominently above foliage.

History.—Introduced in 1899 by W. Atlee Burpee & Co., who describe it as of French origin.

Illustrations.—Dry seeds are shown on Plate IV, 9; snap pods and cross section of same are similar to Lightning (Pl. XIII, 2, and Pl. V, 20, respectively), differing principally in color, and longer, narrower pods, approaching more the shape of the flat-podded type of Southern Prolific (Pl. XVI, 1).

EXTRA EARLY REFUGEE.

Listed by 113 seedsmen. Seeds tested: Burpee, 1901; Ferry, 1899–1901, 1903; Keeney, 1904, 1906; Rawson, 1901; Rice, 1906; Rogers, 1904, 1905; Thorburn, 1901, 1902; Vaughan, 1901.

Description.—Plant medium in size, very erect, without runners or spreading branches, very compact, of well-rounded form, somewhat thick stemmed, green throughout, early, of moderate bearing period, heavily to moderately productive. Leaf medium in size, light green in color, narrow across leaflets. Flowers pink. Snap pods uniform in size, of medium length, curved, round through cross section, deeply creasebacked, light green, brittle, stringy, of inappreciable fiber, of good quality, fairly free from anthracnose. Point of pod long and curved. Green shell pods borne both above and below foliage, sparingly splashed with light purple, quite full on outside between seeds, about 5 inches long, and usually containing 5 or 6 seeds crowded in pod. Dry pods moderately hard to thrash. Dry seeds of medium size,

slender, roundish through cross section, truncate or rounded at ends, straight at eye, bluish black splashed and mottled with pale buff, sometimes almost solid bluish black.

Comparison.—One of the twelve most largely grown bush sorts. A good shipper and of fine appearance on the market and, though not as tender as Burpee's Stringless Green Pod or as fleshy as Red Valentine, it nevertheless makes good snaps for home use, but it is too small podded for satisfactory green shell beans. Similar to Late Refugee only in color of seed and shape of pod, the season being much earlier and vine much more bushy than that variety. Of usefulness similar to Red Valentine and more like it than any other, differing principally in more compact and lower growing vines, and somewhat longer, more slender pods, which become slightly splashed at green shell stage.

Synonyms.—Best of All, Early Market Bush, Bolgiano's Early May Queen, Early May Queen, Excelsior Refugee, May Queen, Page's Extra Early.

Confusing names.—Golden Refugee, Refugee, Late Refugee, Silver Refugee, McKinley Refugee, Galega Refugee, all of which are very different types from Extra Early Refugee.

History.—Introduced in 1888 by J. M. Thorburn & Co.

Illustrations.—Seeds are shown on Plate III, 6; snap pods on Plate VII, 2; cross sections of snap pods are similar to Refugee (Pl. V, 12), differing principally in thicker shape.

FRENCH FLAGEOLET.

Listed by 1 seedsman. Seeds tested: Vincent, 1905, 1906.

Description.—Plant large, very erect, without runners or spreading branches, thick stemmed, green throughout, intermediate-early in season, long in bearing, heavily productive. Leaf large, medium green, of somewhat rough surface. Flowers white. Snap pods uniform in size, very long, moderately curved, oval-flat through cross section, very light green, very tough, very stringy, of much fiber, of very poor quality, free from anthracnose. Point of pod extremely long and curved. Green shell pods borne equally above and below foliage, never splashed or colored, moderately depressed between seeds, about 6 inches long, and usually containing 5 or 6 seeds fairly close in pod. Dry pods very easy to thrash. Dry seeds large, long, oval through cross section, generally well rounded at ends, generally much incurved at eye, solid white.

Comparison.—Little known and planted and real value not yet fully established, but, being the longest podded of the early sorts and the only white-seeded, large-podded variety which is early in season, it might sometimes seem to be a useful variety. Possibly valuable as a field bean for northern latitudes where seasons are short for maturing late varieties or for green shell beans or for snap pods to be used in shipping. Unless picked earlier than is customary in America its pods are not satisfactory as snaps for home use and are fully as tough as White Kidney and other field sorts. Most like Canadian Wonder, differing principally in color and shape of seed, earlier season, smaller vine, and shorter, narrower pods.

History.—A very old name of obscure origin.

Illustrations.—Dry seeds are shown on Plate IV, 21; snap pods are similar to Canadian Wonder (Pl. X, 2), differing principally in being considerably narrower and shorter.

FRENCH KIDNEY FIELD.

Listed by 2 seedsmen. Seeds tested: Johnson & Musser, 1905.

Description.—Plant very large, very erect, without runners or spreading branches, very thick stemmed, green throughout, very late as snaps, late as field beans, long in bearing, heavily productive. Leaf large, medium green, and of rough surface.

Flowers light pink. Snap pods somewhat variable in size, long, very characteristically curved back at middle of pod, oval-flat through cross section, dark green, of very rough and coarse surface, very tough, very stringy, of much hard fiber, of very poor quality, free from anthracnose. Point of pod very long, curved, gradually tapering. Green shell pods borne equally above and below foliage, sometimes sparingly splashed with purplish red, moderately depressed between seeds, about 6 inches long, and usually containing 5 or 6 seeds somewhat separated in pod. Dry pods very easy to thrash. Dry seeds large, slender, oval through cross section, generally well rounded at ends, very straight at eye, light garnet brown, splashed with crimson-violet.

Comparison.—Little known and planted in this country. Of similar usefulness to French Mohawk and Red Kidney, the pods differing from latter principally in narrower shape, backward curving at middle, and splashed color of both seed and pods.

History.—An old name of obscure origin.

Illustrations.—Dry seeds are shown on Plate I, 24; green shell pods are as much like those of Red Kidney (Pl. XIV, 1) as any of the illustrations here shown, differing principally in being narrower and curved back at middle of pod.

FRENCH MOHAWK.

Listed by 1 seedsman. Seeds tested: Johnson & Musser, 1906.

Description.—Plant very large, very erect, without runners or spreading branches, thick stemmed, green throughout, very late, long in bearing, very heavily productive. Leaf very large, medium green, and of rough surface. Flowers pink. Snap pods uniform in size, very long, slightly curved, oval through cross section, medium green, very tough, very stringy, of much fiber, very poor in quality, free from anthracnose. Point of pod long and curved. Green shell pods borne equally above and below foliage, splashed with reddish purple, moderately depressed between seeds, about 7⅞ inches long and usually containing 7 or 8 seeds somewhat separated in pod. Dry pods very easy to thrash. Dry seeds large-medium, slender, oval through cross section, truncate or rounded at ends, straight at eye, deep blûish black in color, sparingly splashed with pale buff.

Comparison.—Little known and cultivated in this country. On account of remarkably straight pods and, perhaps, because of other qualities which have not yet been brought out in our limited trials, this variety may, in some cases, prove superior to Canadian Wonder and other varieties of this class. Suitable for both field and garden use and of satisfactory quality as snaps if picked younger than is customary with other varieties. Similar to Mohawk and Canadian Wonder, differing from former principally in larger, coarser vines, later season, and longer pods, and from latter in straighter, narrower pods and splashed color of seed.

History.—Named in 1904 by Johnson & Musser, but previously listed by them as Rapp's Favorite, under which name it was introduced in 1900.

Illustrations.—Dry seeds are shown on Plate III, 8; snap pods are similar to Mohawk (Pl. XII, 4), differing principally in much larger size and longer pod point; also similar to Canadian Wonder (Pl. X, 2), differing principally in being straighter, narrower, and shorter.

GALEGA.

No longer listed by American seedsmen. Seeds tested: Thorburn, 1903, 1905.

Description.—Plant very large, very spreading, with many runners and drooping branches, slender stemmed, green throughout, very late, very long in bearing, very heavily productive. Leaf small, light grayish green, very narrow across leaflets, very smooth, and of very long petiole. Flowers pink. Snap pods uniform in size,

very long, straight, oval-flat through cross section, dark green, somewhat tough, stringy, of moderate fiber, of poor to fair quality, quite free from anthracnose. Point of pod straight and medium in size. Green shell pods borne mostly below foliage, splashed with reddish purple, quite full on outside between seeds, about 6¾ inches long, and usually containing 7 seeds crowded in pod. Dry pods very easy to thrash. Dry seeds of medium size, somewhat slender, oval through cross section, generally rounded at ends, straight at eye, bluish black in color, fairly splashed with pale buff.

Comparison.—This variety, which has never been popular in America, has now almost gone out of cultivation. On account of extremely late season it is of very limited value, although unsurpassed among strictly garden varieties for productiveness, large growth of vine, and uniformity in size and shape of its very large, straight, handsome pods. Similar in general usefulness and value to Hodson Green Pod and more like it in appearance than any other, differing principally in larger, slenderer stemmed plants, with straighter, shorter, thicker, proportionally narrower pods. Differs from Refugee principally in color of seed, larger, later vine, and longer, flatter, tougher pods.

Synonym.—Galega Refugee.

History.—Listed by American seedsmen under this name at least since 1880. Probably a very old type.

Illustrations.—Dry seeds are shown on Plate III, 7; leaf on Plate XXIV, 1; snap pods are more like those of Mohawk (Pl. XII, 4) than any of illustrations, differing in narrower but considerably longer shape, besides being splashed at green shell stage.

GARDEN PRIDE.

No longer listed by American seedsmen. Seeds tested: Jones, 1903–1905; Keeney, 1906; Vaughan, 1904, 1905.

Description.—Plant small-medium, slightly spreading, without runners or decided spreading branches, somewhat slender stemmed, green throughout, early-intermediate in season, of moderate bearing period, moderately productive. Leaf medium in size, light green in color. Flowers white. Snap pods uniform in size, medium in length, scimiter curved, oval-round through cross section, light green in color, brittle, stringless, without fiber, of good quality, somewhat subject to anthracnose. Point of pod long, imperfectly defined, generally curved. Green shell pods borne equally above and below foliage, never splashed or colored, slightly depressed on outside between seeds, about 5 inches long, and usually containing 6 seeds crowded in pod. Dry pods hard to thrash. Dry seeds of medium size, somewhat slender, roundish through cross section, rounded or truncate at ends, almost straight at eye, sliver from pod occasionally attached to eye, solid white except sometimes minute area of faint yellow around eye.

Comparison.—Little known and planted. Of usefulness similar to Red Valentine and Burpee's Stringless Green Pod, and although not quite so productive it has some value over others of its class because of pure white seed. Vine similar to Bountiful, differing principally in less spreading habit, while pods are almost same in appearance as Jones's Green Pod but easily distinguished from it by the very light yellowish green of its green shell pods.

History.—Introduced in 1903 by the originator, A. N. Jones, of Leroy, N. Y.

Illustrations.—Dry seeds are shown on Plate IV, 11; snap pods resemble Extra Early Refugee (Pl. VII, 2), differing principally in stringlessness, larger size, flatter shape, lighter green color, and peculiar scimiter curvature of pod, which is decidedly curved inward at extreme tip end and decidedly curved backward at extreme stem end.

GIANT FORCER.

Listed by 1 seedsman. Seeds tested: Dreer, 1906.

Description.—Plant very large, spreading extensively over ground with heavy, thick-stemmed, drooping branches, but without real runners, wholly green, very late, long in bearing, heavily to moderately productive. Leaf very large, dark green, wide across leaflets, and of very rough surface. Flowers light pink. Snap pods somewhat variable in size, very long, straight, oval-round through cross section, medium green in color, brittle, stringy, of small fiber, of good quality, fairly free from anthracnose. Point of pod short and slightly curved or straight. Green shell pods borne mostly below foliage, sparingly splashed with faint red, full on outside between seeds, about 7⅛ inches long, and usually containing 6 to 8 seeds crowded in pod. Dry pods sometimes hard to thrash. Dry seeds small-medium, short, generally larger at one end than at other, roundish oval through cross section, well rounded at ends, straight or rounded at eye, pale buff in color, sparingly splashed with medium fawn.

Comparison.—New and as yet planted only in an experimental way. Recommended by introducers as excellent for forcing, but as Department trials of this variety have so far been incomplete it is not possible at this time to state its real value in this and other respects. Excepting for smaller size and different color of seed it seems to be similar in appearance and general usefulness to the late type of Best of All, but unlike that variety the stocks are pure and even.

History.—Introduced in 1906 by Henry A. Dreer.

Illustrations.—Snap pods are similar to Best of All (Pl. XI, 3).

GIANT STRINGLESS GREEN POD.

Listed by 78 seedsmen. Seeds tested: Burpee, 1901, 1903; Keeney, 1903, 1904, 1906; Philipps, 1903; Rice, 1903; Thorburn, 1901, 1902.

Description.—Plant large-medium, very erect when young, with a few shoots high above plant, but upon approaching maturity becoming somewhat weighed down and spreading with many outstretched branches, without real runners, somewhat thick stemmed, green throughout, early-intermediate in season, of moderate bearing period, heavily to moderately productive. Leaf medium in size, medium green in color. Flowers light pink. Snap pods somewhat variable in size, very long, generally more or less scimiter curved, sharply constricted between seeds as if drawn tight by a thread and separated into sections, round, deeply creasebacked, dark green, extremely brittle, absolutely stringless, totally without fiber, of very good quality, somewhat subject to anthracnose. Point of pod medium in length, variable in shape, either straight, curled, or twisted. Green shell pods borne mostly above foliage, never appreciably colored or splashed, very much depressed between seeds, about 6 inches long, and usually containing 6 or 7 seeds tightly crowded in pod. Dry pods hard to thrash. Dry seeds of medium size, slender, roundish through cross section, truncate or rounded at ends, straight at eye, solid brownish ocher in color except minute brown area around eye.

Comparison.—One of the most largely grown garden varieties. Except for difference in color of seed, it is sometimes hardly distinguishable from Burpee's Stringless Green Pod and possesses about the same merits and has the same fault of uneven pods described for that variety. For home use there is little to choose between the two varieties but for market use there exists considerable difference of opinion as to which variety is the most profitable. A few days later in season, and pods a little longer, proportionally slenderer, straighter, and more deeply constricted between seeds than Burpee's Stringless Green Pod. Also similar to Knickerbocker and Henderson's Full Measure.

Synonyms.—Bell's Giant Stringless Green Pod, English Stringless, Giant Valentine, Mammoth Stringless Green Pod, Norwood Giant Stringless.

Confusing names.—Jones's Green Pod, Grenell's Stringless Green Pod, both very different types.

History.—Introduced in 1898 by Johnson & Stokes as Giant Stringless Green Pod Valentine.

Illustrations.—Dry seeds are shown on Plate III, 24; snap pods and cross section of same are similar to Burpee's Stringless Green Pod (Pl. IX, 3, and Pl. V, 13, respectively).

GOLDEN REFUGEE.

Listed by 4 seedsmen. Seeds tested: Thorburn, 1902, 1905.

Description.—Plant very large, very spreading, with many runners and drooping branches lying loosely over the ground, thick stemmed, green throughout, very late, very long in bearing, very heavily productive. Leaf small, very light grayish green, very narrow across leaflets, very smooth, and of very long petiole. Flowers pink. Snap pods very uniform in size, medium to long, slightly curved, round through cross section, silvery green in color, brittle, stringy, of inappreciable fiber, of good quality, fairly free from anthracnose. Point of pod long and curved. Green shell pods borne well below foliage, occasionally splashed with reddish purple, quite full on outside between seeds, about 5⅜ inches long, and usually containing 6 seeds crowded in pod. Dry pods moderately hard to thrash. Dry seeds small-medium, proportionally slender, roundish through cross section, rounded or truncate at ends, generally flat at eye, chocolate brown freely splashed with maize yellow.

Comparison.—Department trials have not been extensive enough to determine real value of this little known and planted variety, but it seems to be of usefulness similar to Refugee and perhaps of special value on account of the unusual color of its pods, which are almost as silvery white as those of Crystal Wax. Differs from Refugee principally in being a few days earlier, of lighter colored foliage, smaller vine, and shorter pods; also thought by some to be less productive and hardy.

Synonyms.—McKinley Refugee, Silver Refugee.

Confusing names.—Refugee, Late Refugee, Galega Refugee, Extra Early Refugee, all of which are very different from Golden Refugee.

History.—Apparently first introduced in 1884 by J. M. Thorburn & Co.

Illustrations.—Leaf is shown on Plate XXIV, 3; snap pods and cross section of same are similar to round-podded type of Refugee (Pl. XII, 3, and Pl. V, 12, respectively).

GRENELL'S STRINGLESS GREEN POD.

Listed by 2 seedsmen. Seeds tested: Grennell, 1903–1905.

Description.—Plant large-medium in size, erect when young, slightly spreading when old, without runners or decided spreading branches, somewhat thick stemmed, green throughout, early, of short bearing period, moderately to heavily productive. Leaf medium in size, light green in color. Flowers white. Snap pods uniform in size, very long, curved at tip end only, very flat, light green, brittle, stringless, of inappreciable fiber, of good quality, somewhat subject to anthracnose. Point of pod extremely long, slender, slightly curved. Green shell pods borne both above and below foliage, never colored or splashed, slightly depressed on outside between seeds, about 6⅞ inches long, and usually containing 6 to 8 seeds fairly close in pod. Dry pods generally easy to thrash. Dry seeds large-medium, medium in length, generally well rounded at ends, oval through cross section, generally straight at eye, solid white except small area of medium hazel around eye.

Comparison.—Little known or planted. A good all-round, green-podded sort of similar usefulness to Bountiful and more like it in appearance than any other, differing

in no important respects except in color of seed, a few days later season, longer, flatter, more curved pods, and more erect vines.

Confusing names.—Burpee's Stringless Green Pod, Giant Stringless Green Pod, Jones's Stringless Green Pod, all of which are very different from Grenell's Stringless Green Pod.

History.—Introduced in 1905 by J. Bolgiano & Son and originated by W. H. Grenell, of Pierrepont Manor, N. Y.

Illustrations.—Dry seeds are shown on Plate III, 4; snap pods and cross section of same are similar to Bountiful (Pl. XIII, 1, and Pl. V, 9, respectively).

HENDERSON'S FULL MEASURE.

Listed by 1 seedsman. Seeds tested: Henderson, 1906.

Description.—Plant large-medium, very erect when young, with few shoots high above plant, but upon approaching full development becoming weighed down and spreading with many outstretched branches, without real runners, somewhat thick stemmed, green throughout, early-intermediate in season, of moderate bearing period, heavily to moderately productive. Leaf medium in size, medium green in color. Flowers light pink. Snap pods somewhat variable in size, very long, generally more or less scimiter curved, sharply constricted between seeds as if drawn tight by a thread and separated into sections, round, deeply creasebacked, dark green, extremely brittle, absolutely stringless, totally without fiber, of very good quality. Point of pod medium in length, variable in shape, either straight, curled, or twisted. Green shell pods borne mostly above foliage, never appreciably colored or splashed, very much depressed between seeds, about 6 inches long, and usually containing 6 to 8 seeds very crowded in pod. Dry pods hard to thrash. Dry seeds of medium size, very slender, straight, roundish through cross section, rounded or truncate at ends, uniformly straight at eye, chocolate brown freely splashed and mottled with maize yellow.

Comparison.—This new and as yet little known and cultivated variety has not yet been tested long enough to make an accurate comparison with other varieties, but it is evidently very similar in appearance to Giant Stringless Green Pod and of similar usefulness and value.

History.—Introduced in 1906 by Peter Henderson & Co., and described by them as a cross between Yosemite Wax and Late Refugee.

Illustrations.—Dry seeds are about same shape and size as Longfellow (Pl. I, 20); snap pods and cross section of same are similar to Burpee's Stringless Green Pod (Pl. IX, 3, and Pl. V, 13, respectively), differing principally in larger size and straighter shape.

HODSON GREEN POD.

Listed by 1 seedsman. Seeds tested: Clark, 1905; Keeney, 1906.

Description.—Plant very large, without decided runners, but with many outstretched branches lying loosely over ground, thick stemmed, wholly green, very late, long in bearing, very heavily productive. Leaf medium in size, of very narrow and pointed leaflets, medium green in color. Flowers light pink. Snap pods uniform in size, very long, almost straight, flat, medium green, very tough, very stringy, of much fiber, poor to medium in quality, quite free from anthracnose. Point of pod long and straight or slightly curved. Green shell pods borne mostly below foliage, never appreciably splashed or tinged, about 7½ inches long, and usually containing 6 to 8 seeds crowded in pod. Dry pods very easy to thrash. Dry seeds large-medium, slender, roundish oval through cross section, generally well rounded at ends, straight or slightly incurved at eye, purplish red freely splashed with pale buff.

Comparison.—New and as yet little known and planted. Differs from Hodson Wax only in color of pod and, like that variety, is too tough for home use, but, its pods being extremely large, very handsome, and excellent shippers and the plant usually the most productive, strongest, and rankest grower of all the green-podded bush sorts, it makes a good market gardener's sort for late crops. More like Galega than any other of the green-podded varieties, differing principally in earlier season and larger, flatter pods.

History.—Introduced in 1906 by O. W. Clark & Son, who state the variety was found in a field of Hodson Wax.

Illustrations.—Dry seeds are same as Hodson Wax (Pl. I, 19); snap pods and cross section of same are similar in shape to Currie's Rustproof Wax (Pl. VIII, 1, and Pl. V, 10, respectively), differing principally in being longer and much flatter.

IMPROVED GODDARD.

Listed by 7 seedsmen. Seeds tested: Ferry, 1898, 1900–1902, 1904, 1905.

Description.—Plant large, very erect, with long stems holding plant well up from ground, without runners or spreading branches, thick stemmed, green throughout, late-intermediate in season, long to moderate in bearing period, heavily productive. Leaf medium in size, medium green in color. Flowers light pink. Snap pods very uniform in size, very long, straight, flat, dark green, tough, very stringy, of much fiber, of poor quality, free from anthracnose. Point of pod medium in length and either straight or slightly curved. Green shell pods borne both above and below foliage, abundantly splashed with brilliant red, moderately depressed between seeds, about 7 inches long, and usually containing 6 seeds fairly close in pod. Dry pods easy to thrash. Dry seeds large, very long, oval through cross section, invariably much rounded at ends, generally straight at eye, pale buff in color, freely splashed with purplish red.

Comparison.—One of the lesser grown varieties of the country and much less planted than the old Goddard or Boston Favorite, although much superior to it in earliness and uniformly large, straight, handsome pods. Decidedly the best all-round strictly green shell bean and the best, largest, and most handsome show variety for green shell beans, as well as the most productive of the Horticultural class, but unsuitable for snaps or for field culture. Most like Crimson Beauty, differing principally in productiveness, later season, and larger pods.

History.—Introduced in 1897 by D. M. Ferry & Co., and described as a selection from Boston Favorite or Goddard.

Illustrations.—Green shell pods are shown on Plate XIV, 3; seeds are about same as Boston Favorite (Pl. I, 26); cross sections of snap pods are similar to Mohawk (Pl. V, 17), differing principally in considerably flatter shape and larger size.

IMPROVED YELLOW EYE.

Listed by 11 seedsmen. Seeds tested: Schlegel & Fottler, 1905.

Description.—Plant large, very spreading, with many runners lying loosely over ground, thick stemmed, green throughout, intermediate-early, long bearing, moderately productive. Leaf medium in size, medium green in color. Flowers pinkish white. Snap pods are somewhat variable in size, long-medium, slightly curved, very flat, becoming roundish at green shell stage, light green, very tough and stringy, of much fiber, of poor quality, free from anthracnose. Point of pod medium in length and either straight or slightly curved. Green shell pods borne mostly below foliage, never splashed or colored, much depressed between seeds, about 5⅜ inches long, and usually containing 5 or 6 seeds fairly close in pod. Dry pods easy to thrash. Dry seeds of medium size, proportionally short, roundish through cross section, truncate or rounded at ends, often larger at one end than at the other, straight or rounded at

eye, solid white, except brownish ochre around eye covering about one-fourth of area of bean.

Comparison.—One of the minor field varieties of the country and formerly more largely grown than at present. Of about same usefulness as White Marrow and next to Yellow Eye more like it in appearance than any other, differing principally in color and smaller size of seed and shorter, narrower, better filled pods. Like White Marrow, its pods are too tough in texture and too irregular in shape to make good snaps, but are satisfactory for green shell beans.

History.—Listed by seedsmen in this country at least since 1880.

Illustrations.—Dry seeds are shown on Plate II, 12; green shell pods are similar to Red Cranberry Pole (Pl. XVIII, 3), differing principally in smaller size and flatter shape.

KNICKERBOCKER.

Listed by 1 seedsman. Seeds tested: Henderson, 1902, 1905, 1906.

Description.—Plant large-medium, very erect when young with few shoots high above plant, but, upon approaching maturity, becoming somewhat weighed down and spreading with many outstretched branches, without real runners, somewhat thick stemmed, green throughout, early-intermediate in season, of moderate bearing period, heavily to moderately productive. Leaf medium in size, medium green in color. Flowers light pink. Snap pods somewhat variable in size, very long, generally more or less scimiter curved, sharply constricted between seeds as if drawn tight by a thread and separated into sections, round, deeply creaseback ed, dark green, extremely brittle, absolutely stringless, totally without fiber, of very good quality, somewhat subject to anthracnose. Point of pod medium in length, variable in shape, straight, curled, or twisted. Green shell pods borne mostly above foliage, never appreciably colored or splashed, very much depressed between seeds, about 6 inches long, and usually containing 6 to 8 seeds tightly crowded in pod. Dry pods hard to thrash. Dry seeds large-medium, slender, roundish through cross section, truncate or rounded at ends, straight or slightly incurved at eye, solid purplish brown in color.

Comparison.—This little known and little planted variety has not yet been tested sufficiently by this Office to determine its real value but it appears to be of about same usefulness as Giant Stringless Green Pod, the young pods being hardly distinguishable from those of that variety and the sort differing in no important respect except in color of seed and freedom from flattish pods.

History.—Introduced in 1902 by Peter Henderson & Co., who write that the variety came from Genesee County, N. Y.

Illustrations.—Dry seeds are shown on Plate I, 23; snap pods and cross section of same are similar to Burpee's Stringless Green Pod (Pl. IX, 3, and Pl. V, 13, respectively), differing principally in being longer and straighter.

LATE REFUGEE.

See Refugee.

LIGHTNING.

Listed by 1 seedsman. Seeds tested: Thorburn, 1902, 1905, 1906.

Description.—Plant medium in size, very spreading with many long creeping branches but with only occasional runners, very thick stemmed, more or less purplish tinged at stems and branches, especially at nodes and on fruit spurs, very early, of short bearing period, lightly productive. Leaf medium in size, very dark green, often tinged with brownish purple, very wide across leaflets and of rough surface. Flowers white with pink blotch at upper end of standard and wings extending half way down petals in distinct streaks. Snap pods variable in size, short, variously curved

and bent, very flat, medium green in color, very tough, very stringy, of much fiber, of very poor quality, quite free from anthracnose. Point of pod medium in length, gradually tapering, moderately curved. Green shell pods borne high above foliage on numerous, thick flower stalks and well toward center of plant, dark green, often splashed and tinged with brownish purple, very much depressed between seeds, often vacant seeded, about 5 inches long, and usually containing 5 or 6 seeds well separated in pod. Dry pods very easy to thrash. Dry seeds large-medium in size, medium in length, flattish oval through cross section, rounded or truncate at ends, incurved at eye, somewhat irregular in shape, often bulged out on one side, creamy white in color variously striped with greenish gray to deep putty, largely white in some seeds, largely greenish gray in others.

Comparison.—Little known and planted, and of very little value. Apparently suitable only for extra-early green shell beans and, though the earliest of all for this use, it rarely proves as profitable even for this purpose as Ruby Horticultural, Warwick, or Crimson Beauty. Its plants are unproductive and unreliable, its green shell pods small, twisted, ill shaped, and unattractive, while snap pods are decidedly too tough in texture even for market. About as flat-podded as Emperor William, more spreading than Navy Pea, and less productive than most garden sorts.

Synonym.—Feejee (of about 1875).

History.—Apparently first named in 1901 by J. M. Thorburn & Co.

Illustrations.—Dry seeds are shown on Plate III, 12, and snap pods and cross section of same on Plate XIII, 2, and Plate V, 20, respectively.

LONGFELLOW.

Listed by 52 seedsmen. Seeds tested: Denison, 1903, 1904; Henderson, 1897, 1900, 1902, 1905; Keeney, 1904, 1906; Rogers, 1906; Thorburn, 1901, 1902.

Description.—Plant large-medium, generally more or less spreading and weighed down with heavy outstretched branches, but always without real runners, thick stemmed, green throughout, intermediate in season, of moderate bearing period, generally moderately productive. Leaf large, dark green, wide across leaflets, of somewhat rough surface. Flowers pinkish white. Snap pods variable in size, very long, very straight, round, dark green, brittle, stringy, of slight fiber, of good quality, especially subject to anthracnose. Point of pod extremely long, imperfectly defined, gradually tapering, variously shaped, either straight, twisted, or much curved. Green shell pods borne equally above and below foliage, never appreciably colored or splashed, full on outside between seeds, about $6\frac{5}{8}$ inches long, and usually containing 6 seeds very crowded in pod. Dry pods generally easy to thrash. Dry seeds of medium size, very slender and straight, roundish through cross section, rounded or truncate at ends, uniformly very straight at eye, dingy brownish red freely splashed with pale buff.

Comparison.—One of the lesser grown varieties of the country. Often the best for market gardeners to grow as snaps but too narrow podded for satisfactory green shell beans and somewhat too tough and stringy for home use. Much liked in parts of the South and especially attractive because of long, straight pods, no other round-podded variety being straighter than this one. Although productive in favorable localities, this variety, under unfavorable conditions, succumbs more quickly to anthracnose than any other, and unless a good growth is obtained there is likely to be a considerable number of undersized and imperfectly shaped pods which are abruptly bent, deeply depressed between seeds, and incompletely filled; but whether the growth be good or poor the pods always show coarse, tapering ends, no other variety having such a long and imperfectly defined pod point. Most like Black Val-

entine in appearance and general usefulness, differing principally in later, darker green, coarser growing plants, rounder, darker green pods and seed of different color.

Synonyms.—Emerald Beauty, Emperor of Russia, French Market, French Lead Pencil, French Stringless, Perfectly Straight Round Pod, Steckler's Perfectly Straight Round Pod, Sutton's Perfection.

History.—Introduced in 1895 by Peter Henderson & Co., and described as of European origin.

Illustrations.—Dry seeds are shown on Plate I, 20; snap pods on Plate IX, 1; cross sections of snap pods are about as broad as the round-podded type of Refugee (Pl. V, 12).

LONG YELLOW SIX WEEKS.

Listed by 160 seedsmen. Seeds tested: Buist, 1901; Denison, 1903; Ferry, 1900; Henderson, 1901; Keeney, 1905, 1906; May, 1897; Rogers, 1906; Schlegel & Fottler, 1901; Thorburn, 1897, 1901–1903; Vaughan, 1901.

Description.—Plant medium in size, very erect, without runners or spreading branches, somewhat thick stemmed, green throughout, early, of moderate bearing period, heavily to moderately productive. Leaf medium in size, light green in color. Flowers light pink. Snap pods very uniform in size, long, generally curved at middle, flat, light green, tough, very stringy, of moderate to strong fiber, poor to fair in quality, fairly free from anthracnose. Point of pod long and either straight or slightly curved. Green shell pods borne both above and below foliage, never colored or splashed, slightly depressed between seeds, about 6 inches long, and usually containing 6 seeds, fairly close in pod. Dry pods very easy to thrash. Dry seeds of medium size, slender, roundish oval through cross section, truncate or rounded at ends, straight or slightly incurved at eye, solid straw yellow in color, sometimes shading to coppery yellow, always with minute brownish area around eye.

Comparison.—This variety, which is extensively grown in all parts of the country, has been a standard sort for over seventy years and is to-day one of the five most largely grown green-podded garden varieties. Being an unusually fine shipper, hardy, reliable, fairly productive, handsome, and of even shape, it is one of the best for market gardening, but its pods are too tough to be of good quality as snaps for home use, Bountiful being decidedly preferable for private gardens. Pods more like those of Bountiful than any other, differing principally in being smaller, tougher, curved at middle instead of tip end, while vines are darker green, smaller, and less spreading in habit.

Synonym.—Pride of Newton.

History.—One of the oldest of the present-day sorts. Listed by J. M. Thorburn & Co., at least since 1822.

Illustrations.—Seeds are shown on Plate III, 18; snap pods on Plate X, 1; cross sections of snap pods are similar to Bountiful (Pl. V, 9).

LOW'S CHAMPION.

Listed by 31 seedsmen. Seeds tested: Farquhar, 1905; Rawson, 1902; Rogers, 1904.

Description.—Plant very large, generally erect, without runners or decidedly spreading branches, very thick stemmed, green throughout, late-intermediate in season, long in bearing, moderately to heavily productive. Leaf medium in size, dark green in color, of glossy surface, wide across leaflets. Flowers light pink. Snap pods uniform in size, medium long, extremely wide, straight, flat, dark green, brittle, of inappreciable string, of slight fiber, of good quality, fairly free from anthracnose. Point of pod short, straight, and generally projecting from middle end of pod. Green

shell pods borne mostly below foliage, never appreciably splashed or colored, moderately depressed between seeds, about 5½ inches long, and usually containing 6 or 7 seeds very crowded in pod. Dry pods generally easy to thrash. Dry seeds large-medium, proportionally short, roundish oval through cross section, truncate or rounded at ends, larger at one end than at other, rounded or full at eye, solid deep carmine-violet.

Comparison.—One of the lesser grown varieties of the country. Particularly useful as snaps and green shell beans for home or market, no other variety, except possibly Warren Bush and Ruby Horticultural Bush, combining these two uses so perfectly. The texture of its thick pod walls, which are fully as free from fiber as most of the round-podded sorts, is quite different from that of the soft, fleshy-podded varieties, and its pods are preferred by some for snaps to such varieties as Red Valentine. As green shell beans it is unsurpassed in size and shape of both pod and seed, but has not the advantage of white seed like White Kidney nor of beautifully splashed pods like Ruby Horticultural and Improved Goddard. Especially useful as snaps because fit for this purpose for so long a time. More like Warren Bush than any other, differing in no important respect except color of seed. Next most like Ruby Horticultural in appearance, general usefulness, and value. Pods of very similar shape to Lazy Wife Pole.

Synonym.—Dwarf Red Cranberry.

History.—Introduced in 1884 by the former Aaron Low Seed Company.

Illustrations.—Snap pods are about same shape and size as Warren Bush (Pl. IX, 2).

MARBLEHEAD HORTICULTURAL.

Listed by 2 seedsmen. Seeds tested: Ferry, 1900, 1902; Gregory, 1897, 1905.

Description.—Plant medium in size, very erect, without runners or spreading branches, thick stemmed, green throughout, intermediate in season, long to moderate in bearing period, moderately productive. Leaf large, dark green, wide across leaflets, of smooth surface. Flowers pink. Snap pods uniform in size, long, straight, flat, dark green, somewhat tough, very stringy, of much fiber, of poor to medium quality, fairly free from anthracnose. Point of pod medium in size, slightly curved. Green shell pods borne both above and below foliage, splashed with dull reddish purple, moderately depressed between seeds, about 5⅞ inches long, and usually containing 6 seeds fairly close in pod. Dry pods easy to thrash. Dry seeds large-medium in size, proportionally short, roundish oval through cross section, truncate or rounded at ends, straight at eye, pale buff in color, generally sparingly splashed with violet-purple but with occasional seeds almost solid violet-purple.

Comparison.—Little known and planted. Satisfactory as snaps for market gardening, especially in New England, where Horticultural varieties of all kinds succeed well. Too tough and stringy as snaps for home use. Principally planted for green shell beans, but even for this purpose it will rarely prove as valuable as Improved Goddard, being smaller podded, less productive, and less attractive. Most like Crimson Beauty in appearance as well as in general usefulness and value, and resembling also Ruby Horticultural Bush.

History.—Introduced in 1882 by Jas. J. H. Gregory & Son, who write the variety was obtained from a Mr. Dodge, of Beverly, Mass.

Illustrations.—Dry seeds are shown on Plate II, 24; green shell pods are as much like Improved Goddard (Pl. XIV, 3) as any of illustrations, differing in color of splashing and in smaller, narrower pods.

MOHAWK.

Listed by 121 seedsmen. Seeds tested: Burpee, 1901, 1906; Ferry, 1899, 1900, 1903 Keeney, 1904–1906; May, 1897; Rice, 1905, 1906; Thorburn, 1901, 1902.

Description.—Plant large, very erect, without runners, but sometimes drooping and spreading when old, thick stemmed, green throughout, early, of moderate bearing period, heavily to moderately productive. Leaf large, dark green, wide across leaflets. Flowers light pink. Snap pods variable in length, long, straight, oval-flat through cross section, medium green, tough, very stringy, of much fiber, of poor quality, moderately free from anthracnose. Point of pod medium in length and straight. Green shell pods borne equally above and below foliage, sparingly splashed with reddish purple, about 6¾ inches long, and usually containing 6 seeds crowded in pod. Dry pods easy to thrash. Dry seeds large-medium, long, oval through cross section, truncate or rounded at ends, straight at eye, dark dull violet splashed with pale buff, sometimes almost solid dark dull violet.

Comparison.—A standard garden variety in this country since 1840 and to-day still one of the ten most largely grown bush sorts. Being a fine shipper, extremely hardy, productive, and producing long, straight, handsome pods, it is generally a profitable variety for market gardening, but is decidedly too tough and stringy as snaps for home use. As a green shell bean it is not nearly so large seeded, handsome, or desirable as Improved Goddard or Ruby Horticultural. Similar in appearance and general usefulness to French Mohawk and Long Yellow Six Weeks, differing from latter principally in color of seed, in straighter, flatter, tougher, darker green, splashed pods, and larger, coarser vines.

Synonyms.—Brown Six Weeks, North Star.

History.—Cultivated in this country at least since 1820.

Illustrations.—Dry seeds are shown on Plate III, 10; cross section of snap pods on Plate V, 17; snap pods on Plate XII, 4.

NAVY PEA FIELD.

Listed by 67 seedsmen. Seeds tested: Ferry, 1902, 1905; Johnson & Stokes, 1897.

Description.—Plant large, very spreading, with many runners lying loosely over ground, slender stemmed, green throughout, late for garden snaps, early as a field bean of short bearing period, very heavily productive. Leaf very small, medium green, smooth. Flowers white. Snap pods very uniform in size, very short, straight, flat, becoming almost round at the green shell stage, very light green in color, very tough, very stringy, of much fiber, very poor in quality, free from anthracnose. Point of pod short and straight. Green shell pods borne mostly below foliage, never colored or splashed, moderately depressed on outside between seeds, about 3¾ inches long, and usually containing 6 seeds crowded in pod. Dry pods very easy to thrash. Dry seeds very small, very short, or almost as wide as long, roundish oval through cross section, generally well rounded at ends, full or rounded at eye, solid white.

Comparison.—This variety, represented by many local names and strains and commonly known in the produce trade as Marrow Peas, is the principal field variety of the United States. It is wholly unsuited for use as snaps and green shell beans and is grown only for its dry seeds, its total plantings far excelling those of all garden varieties combined. Similar to Snowflake Pea and Prolific Tree, differing from former principally in later season, flatter pods, larger vine, and larger, rounder seed, and from latter principally in earlier season and smaller vine and pod.

Synonyms.—In certain local markets and with many seedsmen this variety is regarded as identical with Banner Leafless, Bismarck Great German Soup, Boston Pea,

California Branch, California Pea, California Tree, California Wonder, Early Minnesota, June Bush, Marrow Pea, Mountain, Prizewinner, Salzer's Tree, but sometimes Day's Leafless Medium, White Marrow, and other field sorts are also used for these varieties.

History.—Listed by American seedsmen under this name at least since 1872.

Illustrations.—Dry seeds are shown on Plate IV, 2; cross section of snap pods on Plate V, 3; and green shell pods on Plate XIII, 3; leaf is similar to Snowflake (Pl. XXIII, 5).

NE PLUS ULTRA.

Listed by 5 seedsmen. Seeds tested: Burpee, 1901; Denison, 1903; Farquhar, 1904, 1905; Thorburn, 1897, 1900–1902; Weeber & Don, 1906.

Description.—Plant small-medium in size, very erect, without runners or spreading branches, somewhat slender stemmed, green throughout, very early, short in bearing period, moderately productive. Leaf medium in size, medium green in color, smooth. Flowers light pink. Snap pods very uniform, long, slightly curved, oval-flat through cross section, light green, very tough, very stringy, of much fiber, of poor quality, free from anthracnose. Point of pod long and straight. Green shell pods borne both above and below foliage, never colored or splashed, slightly depressed between seeds, about 5⅞ inches long and usually containing about 6 seeds fairly close in pod. Dry pods very easy to thrash. Dry seeds of medium size, long, roundish oval through cross section, solid brownish ocher in color except minute brown area around eye.

Comparison.—Little known or planted in this country, but a standard variety in Europe, where it is largely used for forcing in greenhouses. In America its usefulness is about same as described for Long Yellow Six Weeks, and pods and vines are more like that variety than any other, differing principally in productiveness, earlier season, and smaller, narrower, straighter, tougher pods. Also similar to Vienna Forcing. Considerable difference exists in stocks of this variety, the type here described being that of the earlier, narrower podded strain, which seems to be more generally recognized than the one which is about same as Long Yellow Six Weeks.

History.—Brought over from England about 1880.

Illustrations.—Snap pods and cross section are similar to Vienna Forcing (Pl. XII, 2, and Pl. V, 5, respectively).

PROLIFIC TREE FIELD.

Listed by 24 seedsmen. Seeds tested: Farquhar, 1902; Hastings, 1905; Johnson & Stokes, 1897.

Description.—Plant very large, very spreading, with many runners lying loosely over ground, slender stemmed, green throughout, very late as snaps and field beans, very long in bearing, very heavily productive. Leaf very small, medium green. Snap pods very uniform in size, short, straight, flat, becoming almost round at green shell stage, very light green in color, very tough, very stringy, of much fiber, very poor in quality, very free from anthracnose. Point of pod short and straight. Green shell pods borne mostly below foliage, never colored or splashed, depressed on outside between seeds, about 4¼ inches long, and usually containing 6 or 7 seeds crowded in pod. Dry pods very easy to thrash. Dry seeds small, very short, or almost as wide as long, roundish oval through cross section, generally well rounded at ends, full or rounded at eye, solid white.

Comparison.—A standard field variety of the United States. Wholly unsuited for snaps and green shell beans and grown only for dry seed. More like Navy Pea than any other, differing principally in larger vines, pods, seeds, and much later season.

Synonym.—Mexican tree and many other names of local origin are often applied to this variety, but as is common in field beans these names are very loosely used and often applied to several different types of field varieties.

History.—Name has been in use among American seedsmen at least since 1882.

Illustrations.—Dry seeds, cross section of snap pods, and green shell pods are similar to Navy Pea (Pl. IV, 2. Pl. V, 3, and Pl. XIII, 3, respectively); leaf is similar to Snowflake (Pl. XXIII, 5).

RED KIDNEY FIELD.

Listed by 25 seedsmen. Seeds tested: Gregory, 1902; Grenell, 1903.

Description.—Plant very large, erect, without runners or decidedly spreading branches, thick stemmed, green throughout, very late as garden snaps, intermediate as field beans, of long bearing period, heavily to moderately productive. Leaf large, medium green. Flowers light pink. Snap pods somewhat variable in size, long, straight, flat, dark green, very tough, very stringy, of much fiber, of poor quality, free from anthracnose. Point of pod medium in length and straight. Green shell pods borne both above and below foliage, never appreciably splashed or colored, much depressed on outside between seeds, about 6 inches long, and usually containing 5 seeds fairly close in pod. Dry pods very easy to thrash. Dry seeds large, long, flattish oval through cross section, generally well rounded at ends, straight or slightly incurved at eye, solid purplish brown in some stocks and garnet brown in others.

Comparison.—A standard field variety and grown almost exclusively for dry beans but excellent also as green shell. Grown mainly for export to West Indies and South America and used in New Orleans and in other sections where there are people of Spanish descent. Decidedly too tough podded for use as snaps. Like all field beans this variety is generally bought by seedsmen on the open market and rarely contracted for and specially selected as are the garden varieties. For this reason the variety varies greatly in type, especially in color of seed. Most like White Kidney, differing in no important respect except in color of seed.

History.—A very old sort listed by American seedsmen under that name at least since 1875, but this type was evidently known to farmers long before that date.

Illustrations.—Green shell pods are shown on Plate XIV, 1, seeds on Plate I, 25.

RED VALENTINE.

Listed by 188 seedsmen. Seeds tested: F. Bolgiano, 1903; Buckbee, 1897; Burpee, 1897, 1901, 1903, 1906; Denison, 1903; Cleveland, 1903; Dibble, 1903; Farquhar, 1901; Ferry, 1900, 1901, 1903, 1904; Heiskell, 1903; Keeney, 1903–1906; May, 1897; Philipps, 1903; Rice, 1906; Rogers, 1904–1906; Schlegel & Fottler, 1901; Sioux, 1905; Thorburn, 1901, 1902.

Description.—Plant medium in size, very erect, without runners or spreading branches, slender stemmed, green throughout, early, of moderate bearing period, heavily to moderately productive. Leaf medium in size, medium green in color, very narrow across leaflets. Flowers white. Snap pods uniform in size, of medium length, curved, round-broad through cross section, deeply creasebacked, medium green, extremely brittle, fairly stringy, of inappreciable fiber, of good quality, fairly free from anthracnose. Point of pod long, slightly curved. Green shell pods often borne on long stems very high on plant, never splashed or colored, somewhat depressed between seeds, about 4¾ inches long, and usually containing 5 or 6 seeds very crowded in pod. Dry pods hard to thrash. Dry seeds of medium size, proportionally long, roundish through cross section, truncate or rounded at ends, straight at eye, irregular in shape, often twisted or bulged out in places, purplish red splashed with pale buff.

Comparison.—A standard variety since 1865 and to-day the most extensively planted and generally listed of all garden beans. Popular with market gardeners because so early and reliable and the favorite with home gardeners on account of excellent quality and other good features. Fully as tender, as fleshy, and as long in condi-

tion for use as most of the absolutely stringless varieties. Pods too small for good green shell beans and plant generally less productive than Refugee and Byer's Bush. Of same general usefulness and value as Burpee's Stringless Green Pod and Extra Early Refugee, differing from the latter principally in color of seed, taller vine, more open habit, and more fleshy pods. Differs from Cream Valentine and White Valentine only in color of seed and greater productiveness. Quite different from Black Valentine in color of seed, smaller vine, and thicker, tenderer pods.

Synonyms.—Buckbee's Early Wonder Bush, Buist's Early Lightning Valentine, Early Wonder Bush, Lightning Valentine, Wood's Earliest Red Valentine.

Confusing names.—Black Valentine, Brown-Speckled Valentine, Cream Valentine, Giant Valentine, White Valentine, all of which are very different from Red Valentine.

History.—Known in this country at least since 1845. The present day type is quite different from the flat-podded type in common use previous to 1870.

Illustrations.—Dry seeds are shown on Plate I, 13; snap pods on Plate VII, 3; and leaf on Plate XXIII, 6; cross sections of snap pods are similar to Burpee's Stringless Green Pod (Pl. V, 13), differing principally in smaller size.

REFUGEE.

Listed by 115 seedsmen. Seeds tested: F. Bolgiano, 1903; Burpee, 1901; Farquhar, 1901; Ferry, 1899–1901, 1903; Grenell, 1905; Haskell, 1903; Keeney, 1904–1906; Livingston, 1901; Maule, 1905; Philipps, 1903; Rogers, 1904; Thorburn, 1901, 1902.

Description of round-podded type.—Plant very large, very spreading, with many semirunners and drooping branches lying loosely over ground, slender stemmed, green throughout, very late, very long in bearing, very heavily productive. Leaf small, light grayish green, very narrow across leaflets, of smooth surface, of very long petiole. Flowers pink. Snap pods uniform in size, medium long, slightly curved, round, medium green, brittle, stringy, of inappreciable fiber, of good quality, fairly free from anthracnose. Point of pod long and curved. Green shell pods borne well below foliage, splashed with reddish purple, quite full on outside between seeds, about $5\frac{3}{8}$ inches long, and usually containing 6 seeds crowded in pod. Dry pods, moderately hard to thrash. Dry seeds of medium size, slender, roundish through cross section, truncate or rounded at ends, straight at eye, mostly violet-purple, but always more or less splashed with pale buff.

Description of flat-podded type.—Same as above except pods are flattish oval in shape, somewhat tough, more stringy, and of fair quality.

Comparison of round-podded type.—One of the five most largely grown bush sorts, and the only late snap bean planted to any extent in this country. Largely grown by southern gardeners for northern shipment and more extensively used by canners than any other variety. One of the most hardy, reliable, and productive of all snap beans, the only late, round-podded sorts comparing with it in these respects being Golden Refugee and Byer's Bush. Too narrow podded for good green shell beans. More like Golden Refugee than any other, differing principally in color of seed, larger vine, a few days later season, and darker colored pods. Differs from Extra Early Refugee principally in greater productiveness, later season, larger vine, and longer, straighter pods.

Comparison of flat-podded type.—Now largely replaced by the improved strain described above, which, because of its rounder, tenderer, and less stringy pods, is generally regarded as by far the best strain.

Synonyms.—Brown-Speckled Valentine, Thousand to One, Late Prolific Refugee.

Confusing names.—Extra Early Refugee, Golden Refugee, Galega Refugee, McKinley Refugee, Silver Refugee, all of which are very different from Refugee.

History.—One of the oldest varieties cultivated in this country. Listed by J. M. Thorburn & Co. since 1822.

Illustrations.—Dry seeds of round-podded type are shown on Plate III, 5; snap pods of round type are shown on Plate XII, 3; cross sections of snap pods of round and flat-podded types on Plate V, 11 and 12, respectively.

ROUND YELLOW SIX WEEKS.

Listed by 35 seedsmen. Seeds tested: Burpee, 1901; Ferry, 1900; Keeney, 1904, 1906; Rogers, 1904.

Description.—Plant small-medium in size, very erect, bushy, compact, without runners or spreading branches, slender stemmed, green throughout, early-intermediate in season, of moderate bearing period, moderately productive. Leaf medium in size, light green in color, and of smooth surface. Flowers light pink. Snap pods very uniform in size, medium in length, straight, oval through cross section, becoming round at green shell stage, light green in color, brittle, of inappreciable string, of small fiber, of good quality, fairly free from anthracnose. Point of pod short and either slightly curved or straight. Green shell pods borne equally above and below foliage, never appreciably colored or splashed, much depressed between seeds, about 4½ inches long, and usually containing 5 or 6 seeds tightly crowded in pod. Dry pods moderately hard to thrash. Dry seeds small-medium, proportionally short, roundish through cross section, generally well rounded at ends, flat at eye, sliver from pod commonly attached to eye, solid straw in color, sometimes tinged with coppery yellow, but always with minute dark brownish area around eye.

Comparison.—This secondary garden variety is too small seeded and short podded to make good green shell beans, and is decidedly lacking in vigor and productiveness for profitable field beans, but is excellent as early snaps for either home or market, being specially valuable because of its reliability, hardiness, high quality, and uniform size and shape of pods. More like Taylor's Green Pod than any other, and next most like China Red Eye, differing principally in earlier season, peculiarly well rounded habit of growth, and rounder, shorter, stringless pods.

History.—Grown in this country at least since 1865.

Illustrations.—Dry seeds are shown on Plate I, 4; snap pods on Plate XIII, 5.

RUBY HORTICULTURAL BUSH.

Listed by only 3 seedsmen under this name and by 101 under name of Dwarf Horticultural. Seeds tested: Rogers, 1904.

Description.—Plant medium in size, of very erect, well rounded, compact form, without runners or spreading branches, thick stemmed, wholly green, early, of moderate bearing period, fairly productive. Leaf large, dark green, unusually wide across leaflets. Flowers light pink. Snap pods uniform in size, medium in length, slightly curved, flat, becoming almost round at green shell stage, dark green, brittle, stringless, of inappreciable fiber, of medium quality, quite free from anthracnose. Point of pod short and straight. Green shell pods borne both above and below foliage, freely splashed with brilliant red, moderately depressed between seeds, about 5½ inches long, and usually containing 6 seeds tightly crowded in pod. Dry pods sometimes hard to thrash. Dry seeds large-medium, proportionally short, oval through cross section, generally truncate at ends, rounded or full at eye, pale buff in color, freely splashed with purplish red.

Comparison.—One of the standard variety types of the country, but generally known and sold under name of Dwarf Horticultural. Excellent as snaps or green shell beans for home or market, no other variety, except possibly Low's Champion and Warren Bush,

combining these two uses so perfectly. Superior to above varieties in earliness and beautifully splashed pods, but not nearly so productive nor so long in bearing. Most like Marblehead Horticultural in appearance, differing principally in earlier season and smaller, stringless, reddish splashed pods with smaller, more compact vine.

Synonyms.—Carmine-Podded Horticultural Bush, Dwarf Horticultural, Early Carmine-Podded Horticultural, Speckled Cranberry Bush.

History.—Introduced in 1888 by James J. H. Gregory & Son as Early Carmine-Podded Horticultural Bush, which name was substituted by seedsmen a few years later for Ruby Horticultural Bush, by which the type is now best known.

Illustrations.—Dry seeds are shown on Plate I, 7; leaf on Plate XXIII, 7; while snap pods are similar in shape to Mohawk (Pl. XII, 4), differing principally in being shorter and proportionally wider; green shell pods are splashed similar to and are almost as wide as Improved Goddard (Pl. XIV, 3).

SNOWFLAKE FIELD.

Listed by 4 seedsmen. Seeds tested: Gregory, 1897; Johnson & Stokes, 1897; Keeney, 1904–1906.

Description.—Plant large, very spreading, with many runners lying loosely over ground, slender stemmed, green throughout, intermediate in season as snaps, very early as field beans, short in bearing period, heavily productive. Leaf very small, medium green, and of smooth surface. Flowers white. Snap pods very uniform in size, very short, straight, flat, becoming almost round at green shell stage, very light green, very tough, very stringy, of much fiber, of very poor quality, very free from anthracnose. Point of pod short and straight. Green shell pods borne mostly below foliage, never colored or splashed, depressed on outside between seeds, about $3\frac{3}{4}$ inches long, and usually containing 6 or 7 seeds crowded in pod. Dry pods very easy to thrash. Dry seeds very small, proportionally short, roundish oval through cross section, generally well rounded at ends, full or rounded at eye, solid white.

Comparison.—Strictly a field variety. Planted only for dry beans and wholly unsuited for use as snaps and green shell beans. Very similar to Navy Pea and of same general usefulness and value, differing only in smaller seeds, earlier season, narrower pods, and smaller, less productive vine. Except California Small White, the smallest seeded of the field beans.

History.—Introduced in 1888 by James J. H. Gregory & Son.

Illustrations.—Dry seeds are shown on Plate IV, 1; leaf on Plate XXIII, 5; cross section of snap pods and green shell pods are similar to Navy Pea (Pl. V, 3, and Pl. XIII, 3, respectively), differing principally in flatter shape.

TAYLOR'S GREEN POD.

Listed by 1 seedsman. Seeds tested: Wood, Stubbs, & Co., 1905.

Description.—Plant very small, very erect, bushy, compact, low growing, of well-rounded form, always without runners and spreading branches, somewhat slender stemmed, green throughout, very early, of moderate bearing period, lightly to moderately productive. Leaf small, smooth, dark green. Flowers light pink. Snap pods very uniform in size, medium in length, straight, oval-round through cross section, but becoming round at green shell stage, light green in color, brittle, inappreciably stringy, of slight fiber, of good quality, free from anthracnose. Point of pod short and either straight or slightly curved. Green shell pods borne equally above and below foliage, never appreciably colored or splashed, much depressed on outside between seeds, about $4\frac{1}{2}$ inches long, and usually containing 5 or 6 seeds very tightly crowded in pod. Dry pods moderately hard to thrash. Dry seeds small-medium, proportionally short, roundish through cross section, well rounded at ends, larger at one end than at other,

rounded or flat at eye, mostly straw yellow in color, but varying to coppery yellow, always with minute brownish area around eye.

Comparison.—This little known and planted variety is of same general usefulness and value as described for Round Yellow Six Weeks and so similar in appearance as often to be thought identical. Its pods are somewhat flatter, a little shorter, and a few days earlier in season, while the plants are smaller, lower growing, and more compact in habit than any variety of American origin.

History.—Introduced in 1902 by Wood, Stubbs, & Co., who state the variety originated in Oldham County, Ky., with a Mr. Oldham.

Illustrations.—Dry seeds are shown on Plate I, 3; snap pods are very similar to Round Yellow Six Weeks (Pl. XIII, 5), differing principally in being slightly shorter and flatter.

TENNESSEE GREEN POD.

Listed by 2 seedsmen. Seeds tested: Ferry, 1904–1906; Schwill, 1905.

Description.—Plant large, very spreading, with many semirunners and drooping branches, very thick stemmed, green throughout, early-intermediate in season, long in bearing, heavily to moderately productive. Leaf large, very dark green, very wide across leaflets, and of rough surface. Flowers white. Snap pods somewhat variable in size, long, moderately curved, often much bent to one side, very flat, deeply depressed at dorsal suture, very angular or narrowed at ventral suture, medium green, somewhat tough, stringy, of moderate fiber, of poor to medium quality, free from anthracnose. Point of pod moderately long and curved. Green shell pods generally borne well above foliage on thick fruit spurs, never splashed or appreciably colored except for black lines along sutures, very much depressed between seeds, much thicker at ventral than at dorsal side, about 6¾ inches long, and usually containing 7 seeds much separated in pod. Dry pods fairly easy to thrash. Dry seeds of medium size, proportionally short, oval through cross section, generally well rounded at ends, straight at eye, solid dark hazel in color.

Comparison.—This little known and planted variety is much liked in Tennessee and the South, and is said to grow very well at the North. Although especially recommended as a green shell bean, it may be used also for snaps, as its pods are thicker and more tender than Emperor William and other flat-podded varieties of its class. Unsuited for field culture because of colored seed, coarse growth, and less productiveness and hardiness than strictly field varieties. Most like Emperor William, differing principally in color of seed, narrower pods, more spreading vine, and with fruit stalks more prominently above foliage. Pods peculiar for being more sunken between seeds than is the case in any other variety.

Synonyms.—Field's First Early, Brown Bunch.

History.—Introduced in 1904 by D. M. Ferry & Co., but known in the South some time before that date, especially near Knoxville, Tenn.

Illustrations.—Dry seeds are shown on Plate III, 19; cross sections of green shell pods on Plate V, 29 and 30; and green shell pods on Plate XIV, 2.

THORBURN'S PROLIFIC MARKET.

No longer listed by American seedsmen. Seeds tested: Thorburn, 1897, 1903, 1904; Weeber & Don, 1902.

Description.—Plant large, very spreading, with moderate number of runners and long branches lying loosely over ground, somewhat thick stemmed, green throughout, very late, of very long bearing period, very heavily productive. Leaf small, narrow, pointed, dark green. Flowers pink. Snap pods variable in size, very long, curved, oval-round through cross section, dark green, tough, stringy, of moderate fiber, of fair

quality, fairly free from anthracnose. Point of pod very long and moderately curved. Green shell pods borne mostly below foliage, never appreciably splashed or colored, full on outside between seeds, about 7 inches long, and usually containing 6 or 7 seeds fairly close in pod. Dry pods easy to thrash. Dry seeds large-medium, very slender, flattish oval through cross section, rounded or truncate at ends, incurved at eye, solid black in color.

Comparison.—This little known variety has been grown to a small extent in this country, but has always proven so uneven and impure, so late in season, and so generally unsuited to American climate that it has now mostly gone out of cultivation. Its pods vary greatly in shape, some being as round and long as the late type of Best of All, and others as flat and short as Mohawk. The greater portion of pods, however, are similar in appearance to Galega, differing principally in being rounder, longer, more irregular in shape, smaller in vine, less productive, and less reliable.

History.—Introduced from Germany about 1894 by J. M. Thorburn & Co.

Illustrations.—Snap pods are shown on Plate XI, 1; dry seeds do not closely resemble any of illustrations, but are about same color as Black Valentine (Pl. III, 20).

TRIUMPH OF FRAMES.

Listed by 7 seedsmen. Seeds tested: Dreer, 1905, 1906; Thorburn, 1897, 1901, 1902.

Description.—Plant small, short stemmed, very erect, compact, and dense in habit, without runners or spreading branches, somewhat slender stemmed, green throughout, intermediate in season, of moderate to long bearing period, heavily to moderately productive. Leaf of medium-small size, very dark green, wide across leaflets, and of rough surface. Flowers white. Snap pods uniform in size, of medium length, much curved, oval-round through cross section, much narrowed and occasionally twisted at stem end, very dark green, very tough and stringy, of much fiber, of very poor quality, very free from anthracnose. Point of pod of medium size very slender, moderately curved. Green shell pods borne on numerous stiff clusters prominently above foliage, never splashed but always remaining more or less greenish in color, very full between seeds, about 5½ inches long, and usually containing 5 or 6 seeds fairly close in pod. Dry pods very easy to thrash. Dry seeds of medium size, slender, flattish oval through cross section, rounded or truncate at ends, generally straight at eye, solid sea green in color.

Comparison.—Little known or planted in this country, but a great favorite in Europe for forcing in greenhouses. Highly esteemed by some because of its green-colored seeds, which, after being soaked and cooked, retain their green color almost as well as fresh beans from the garden. In this country, however, there is but a small demand for this class of dried beans, and since snap pods are rarely gathered as young and undersized as is customary in Europe, this variety will be found too tough and stringy for outdoor culture as snaps. Unless plants are pulled a little before thoroughly ripe and dry and unless care is taken to protect the pods from sun and rain during the curing period, the dry seed, instead of being clear green in color, will bleach and fade almost to solid white. Most like Wonder of France, differing principally in rounder, better filled, and more attractive pods, which are peculiar for their extremely dark green color and very narrowed stem end.

History.—A foreign sort first listed by American seedsmen about 1894.

Illustrations.—Snap pods are shown on Plate VIII, 4; cross section of snap pod on Plate V, 4.

VEITCH'S FORCING.

No longer listed by American seedsmen. Seeds tested: Thorburn, 1905, 1906.

Description.—Plant small, very erect, bushy, close jointed, dense in habit, without runners or spreading branches, green throughout, early, long to moderate in bearing period, moderately productive. Leaf small, medium green. Flowers light pink.

Snap pods uniform in size, of medium length, much curved, oval-flat through cross section, much narrowed at stem end, dark green in color, very tough and stringy, of much hard fiber, of poor quality, fairly free from anthracnose. Point of pod medium in size, very slender, moderately curved. Green shell pods borne in numerous clusters prominently above foliage, never colored or splashed, full on outside between seeds, about 5 inches long, and usually containing 5 or 6 seeds fairly close in pod. Dry pods easy to thrash. Dry seeds small, slender, flattish oval through cross section, truncate or rounded at ends, straight or slightly incurved at eye, solid brownish terra cotta in color.

Comparison.—Little known or planted in this country, but used in England for forcing in greenhouses and recommended by some American seedsmen for this purpose. Decidedly too narrow podded and small seeded for good green shell beans and too tough podded as snaps for outdoor growing in America. Of usefulness and value similar to Vienna Forcing and Ne Plus Ultra; also like them in general appearance. Pods of similar shape to Wonder of France and Triumph of Frames.

History.—An English sort of recent introduction. Not listed after 1905 by J. M. Thorburn & Co., who seem to be the only seedsmen who have ever listed the variety in this country.

Illustrations.—Snap pods and cross sections are similar to Triumph of Frames (Pl. VIII, 4, and Pl. V, 4, respectively), differing principally in color of seed and in lighter green and decidedly flatter pods.

VICK'S PROLIFIC PICKLER.

Listed by 1 seedsman. Seeds tested: Vick, 1905.

Description.—Plant very large, very erect, without runners or spreading branches, thick stemmed, green throughout, very late, long in bearing period, very heavily productive. Leaf large, dark green, and of somewhat rough surface. Flowers light pink. Snap pods variable in size, very long, very curved, flat, of very rough and coarse surface, dark green, very tough, very stringy, of much hard fiber, very poor in quality, free from anthracnose. Point of pod long and slightly curved. Green shell pods borne both above and below foliage, never appreciably colored or splashed, much depressed between seeds, about 8⅜ inches long, and usually containing 7 or 8 seeds somewhat separated in pod. Dry pods easy to thrash. Dry seeds large, long, very flattish oval through cross section, truncate or rounded at ends, straight or incurved at eye, solid plum violet in color.

Comparison.—This little known and planted variety is similar to and of same usefulness as Canadian Wonder, differing from it in no important respects except color of seed and larger, more curved pods.

Synonyms.—Gunkler, Prolific Pickler.

History.—Introduced in 1895 by James Vick's Sons, and said to have been brought from Germany by gardeners near Rochester, N. Y., by whom it is known as Gunkler.

Illustrations.—Dry seeds are shown on Plate III, 23; green shell pod and leaf resemble Canadian Wonder (Pl. X, 2, and Pl. XXIV, 6, respectively), differing principally in longer and more curved pods.

VIENNA FORCING.

Listed by 1 seedsman. Seeds tested: Thorburn, 1900–1903, 1905, 1906.

Description.—Plant small-medium in size, very erect, close jointed, compact, without runners or spreading branches, somewhat thick stemmed, green throughout, very early, of short bearing period, moderately productive. Leaf medium in size, medium green in color. Flowers light pink. Snap pods very uniform in size, long, slightly curved, oval-flat through cross section, light green, very tough, very stringy, of much fiber, of poor quality, free from anthracnose. Point of pod long and straight. Green

shell pods borne both above and below foliage, never colored or splashed, slightly depressed between seeds, about 5⅞ inches long, and usually containing about 6 seeds fairly close in pods. Dry pods very easy to thrash. Dry seeds of medium size, slender, oval through cross section, truncate or rounded at ends, generally straight at eye, solid white except small area of brownish ocher around eye.

Comparison.—Little known or planted in this country, but used in Europe for forcing in greenhouses and recommended by American seedsmen for this purpose. Unless gathered at an extremely young stage, as is customary in Europe, this variety will prove unsuited as snaps for outdoor growing in America. Too narrow podded, small seeded, and unproductive for satisfactory green shell beans. Of same general usefulness and value as Ne Plus Ultra, the pods of the two varieties being hardly distinguishable except for color of seed, smaller vine, and more compact, bushy habit.

History.—A German variety of recent introduction.

Illustrations.—Dry seeds are shown on Plate III, 2; snap pods on Plate XII, 2; and cross section of snap pod on Plate V, 5.

VINELESS MARROW FIELD.

Listed by 1 seedsman. Seeds tested: Burpee, 1901; Ferry, 1900, 1902, 1905.

Description.—Plant large, erect, without runners or spreading branches, thick stemmed, wholly green throughout, late as garden snaps, intermediate as field beans, long to moderate in bearing period, heavily productive. Leaf large, medium green. Flowers white. Snap pods somewhat variable in size, long-medium, slightly curved, very flat, light green, very tough, very stringy, of much fiber, of poor quality, free from anthracnose. Point of pod medium in size and either straight or slightly curved. Green shell pods borne both above and below foliage, never splashed or colored, much depressed between seeds, about 5⅜ inches long, and usually containing 5 or 6 seeds fairly close in pod. Dry pods very easy to thrash. Dry seeds of medium size, somewhat short, roundish oval through cross section, invariably well rounded at ends, much larger at one end than at other, rounded or straight at eye, solid white.

Comparison.—A strictly field variety and suitable for green shell beans, but decidedly too tough for use as snaps. The variety may be described as an erect form of the common White Marrow, differing from it in no important respect except for freedom from runners and in late season. Of about same habit as Red Kidney.

History.—Grown to a limited extent in western New York, but never brought prominently before public until listed by D. M. Ferry & Co. in 1897.

Illustrations.—Dry seeds are shown on Plate IV, 14; green shell pods are more like Red Kidney (Pl. XIV, 1) than any of the bush varieties here illustrated, differing principally in being smaller and more curved or approaching the shape of Concord Pole (Pl. XX, 2).

WARREN BUSH.

Listed by 11 seedsmen. Seeds tested: Farquhar, 1905; Iowa Seed Company, 1902; Rogers, 1904, 1906.

Description.—Plant very large, generally erect, without runners or decided spreading branches, very thick stemmed, green throughout, late-intermediate in season, long bearing, heavily productive. Leaf medium in size, dark green in color, of glossy surface, wide across leaflets. Flowers light pink. Snap pods uniform in size, long-medium, straight, flat, dark green, brittle, of inappreciable string, of small fiber, of good quality, free from anthracnose. Point of pod short, straight, and generally borne from middle end of pod. Green shell pods borne mostly below foliage, never appreciably splashed or colored, moderately depressed between seeds, about 5½ inches long, and usually containing 6 or 7 seeds very crowded in pod. Dry pods generally easy to thrash. Dry seeds large-medium, proportionally short, roundish oval through cross

section, generally well rounded at ends, larger at one end than at other, round or full at eye, solid blackish violet in color.

Comparison.—One of the lesser grown varieties of the country and of same usefulness and value as Low's Champion, differing from it in no important respect except for an immaterial difference in color of seed.

History.—Introduced about 1884 by several American seedsmen and originated by David Warren, of Essex County, Mass.

Illustrations.—Dry seeds are shown on Plate II, 11, and snap pods on Plate IX, 2.

WARWICK.

Listed by 3 seedsmen. Seeds tested: Henderson, 1900, 1905; Thorburn, 1901, 1902.

Description.—Plant medium in size, very erect, without runners or spreading branches, somewhat thick stemmed, green throughout, very early, of short bearing period, lightly to moderately productive. Leaf medium in size, medium green in color. Flowers light pink. Snap pods uniform in size, medium in length, straight, flat, light green, tough, very stringy, of much fiber, poor in quality, free from anthracnose. Point of pod medium in length, and either slightly curved or straight. Green shell pods borne equally above and below foliage, sparingly splashed with light red, moderately depressed between seeds, about 5½ inches long, and generally containing 5 or 6 seeds crowded in pod. Dry pods easy to thrash. Dry seeds medium in size, proportionally medium in length, roundish oval through cross section, truncate or rounded at ends, rounded or straight at eye, purplish red sparingly splashed with pale buff, sometimes almost solid purplish red.

Comparison.—This little known and planted variety is sometimes valuable because of its extreme earliness, but is of no superior value in other respects. It gives snap pods before any other green-podded variety, preceding by a few days Bountiful and Red Valentine, while as green shell beans it is second in earliness to Lightning. Its pods are, however, somewhat too tough to be satisfactory for home use and too short and small seeded to make attractive green shell beans. Variety is also deficient in productiveness and length of bearing period. Of similar usefulness to China Red Eye and more like it in appearance than any other. Unlike that variety, it is too unproductive and of too small growth to be suitable for field beans and differs further in color of seed and smaller, flatter, straighter, splashed pods.

History.—Introduced about 1890 by Peter Henderson & Co., who state the variety came from England.

Illustrations.—Dry seeds are shown on Plate I, 14; snap pods are similar in shape to China Red Eye (Pl. XI, 2), differing principally in that pods are shorter, flatter, and straight at stem end.

WHITE KIDNEY FIELD.

Listed by 53 seedsmen. Seeds tested: Keeney, 1906; Thorburn, 1897, 1901, 1903, 1905.

Description.—Plant very large, erect, without runners or decidedly spreading branches, thick stemmed, green throughout, late as snaps and field beans, of long bearing period, moderately productive. Leaf large, medium green. Flowers white. Snap pods somewhat variable in size, long, straight, flat, light green, very tough, very stringy, of much fiber, of poor quality, free from anthracnose. Point of pod medium in length and straight. Green shell pods borne both above and below foliage, never splashed or colored, much depressed on outside between seeds, about 6 inches long, and usually containing 5 seeds fairly close in pod. Dry pods very easy to thrash. Dry seeds large, slender, oval through cross section, generally well rounded at ends, straight or slightly incurved at eye, solid white.

Comparison.—A well-known field variety grown to a limited extent in most of the bean-growing sections of the country. Excellent for green shell beans, but decidedly too tough for snaps. Except in color of seed the variety is almost the same as Red Kidney. Resembles Vineless Marrow in size and shape of seed.

Synonym.—Royal Dwarf Kidney.

History.—Cultivated in this country at least since 1825 and one of the oldest cultivated varieties.

Illustrations.—Dry seeds are shown on Plate IV, 22; green shell pods are similar to Red Kidney (Pl. XIV, 1).

WHITE MARROW FIELD.

Listed by 85 seedsmen. Seeds tested: Burpee, 1901; Ferry, 1900, 1902; Keeney, 1904, 1905; Thorburn, 1897, 1901, 1905.

Description.—Plant very large, very spreading, with many runners lying loosely over ground, thick stemmed, green throughout, late as garden snaps, intermediate in season as a field bean, of moderate bearing period, heavily to moderately productive. Leaf medium in size, medium green in color. Flowers white. Snap pods somewhat variable in size, long-medium, slightly curved, very flat, changing to somewhat oval at green shell stage, light green, very tough, very stringy, of much fiber, of poor quality, free from anthracnose. Point of pod medium in length and either straight or slightly curved. Green shell pods borne mostly below foliage, never splashed or colored, much depressed between seeds, about 5⅜ inches long, and usually containing 5 or 6 seeds fairly close in pod. Dry pods very easy to thrash. Dry seeds of medium size, proportionally short, roundish through cross section, invariably well rounded at ends, much larger at one end than at other, rounded or full at eye, solid white.

Comparison.—A standard field variety in all the bean-growing sections of the country, the total plantings of the variety exceeding those of any strictly garden variety. Suitable for green shell beans, but too tough, stringy, and imperfect in shape for good snaps. More like Vineless Marrow than any other, differing principally in more spreading habit and later season.

Synonyms.—Dwarf White Cranberry, Great Western.

History.—A very old variety, cultivated in this country at least since 1825.

Illustrations.—Dry seeds are shown on Plate IV, 15; green shell pods are more like those of Red Kidney (Pl. XIV, 1) than any of the bush varieties here illustrated, differing principally in being smaller and more curved, or approaching more the shape of Concord Pole (Pl. XX, 2).

WHITE VALENTINE.

Listed by 8 seedsmen. Seeds tested: Rice, 1903, 1905; Thorburn, 1897.

Description.—Plant medium in size, very erect, absolutely without runners or spreading branches, slender stemmed, green throughout, early, of moderate bearing period, moderately productive. Leaf medium in size, medium green in color, very narrow across leaflets, smooth. Flowers white. Snap pods uniform in size, of medium length, curved, round-broad through cross section, deeply creasebacked, medium green, extremely brittle, stringy, of inappreciable fiber, of good quality, fairly free from anthracnose. Point of pod long and slightly curved. Green shell pods borne high on plant and mostly above foliage, never colored or splashed, somewhat depressed between seeds, about 4¾ inches long, and usually containing 5 or 6 seeds very crowded in pod. Dry pods hard to thrash. Dry seeds of medium size, proportionally long, roundish through cross section, truncate or rounded at ends, straight at eye, generally irregular in shape, often twisted or bulged out in places, solid white in color

Comparison.—Although seemingly possessing the good qualities of Red Valentine and having in addition the advantage of white seed and greater earliness, this variety

has never been largely grown in this country. The reason of its unpopularity is said by some growers to be the low germination of its seed and its lack of productiveness, but these facts have not yet been demonstrated in Department trials. Differs in appearance from Red Valentine in color of seed and possibly in lighter green pods.

Synonyms.—Union White Valentine.

Confusing names.—Black Valentine, Brown-Speckled Valentine, Cream Valentine, Giant Valentine, Red Valentine, all very different from White Valentine.

History.—First listed by American seedsmen about 1870.

Illustrations.—Dry seeds and snap pods are similar to Red Valentine (Pl. I, 13, and Pl. VII, 3, respectively), differing only in color of seeds; cross sections of snap pods are similar to Burpee's Stringless Green Pod (Pl. V, 13), differing principally in being smaller.

WONDER OF FRANCE.

Listed by 7 seedsmen. Seeds tested: Farquhar, 1905; Woeber & Don, 1906.

Description.—Plant large-medium, erect, of somewhat dense growth, without runners or spreading branches, somewhat thick stemmed, green throughout, early, of long to moderate bearing period, heavily to moderately productive. Leaf medium in size, very dark green, wide across leaflets. Flowers white. Snap pods uniform in size, medium in length, moderately curved, flat, much narrowed at stem end, occasionally twisted, often bent to one side, very dark green, very tough and stringy, of much fiber, of very poor quality, very free from anthracnose. Point of pod very slender, medium in length, moderately curved. Green shell pods borne on numerous stiff clusters prominently above foliage, never splashed, always more or less greenish tinged, slightly depressed between seeds, about 5½ inches long, and usually containing 5 or 6 seeds fairly close in pod. Dry pods easy to thrash, generally greenish in color. Dry seeds medium in size, slender, flattish oval through cross section, rounded or truncate at ends, generally straight at eye, solid sea green in color.

Comparison.—Little known or cultivated in this country, but well known in Europe, where it is valued in same way as described for Triumph of Frames. More like that variety than any other, but, because of more spreading habit and less uniform shape, it is not generally as desirable or as handsome for snap pods.

Synonyms.—Green Gem, Green-Seeded Flageolet.

History.—Of French origin and first listed by American seedsmen about 1880.

Illustrations.—Snap pods and cross sections are similar to Triumph of Frames (Pl. VIII, 4, and Pl. V, 4, respectively), differing principally in being much flatter, more twisted, bent, and irregular in shape.

YANKEE WINTER.

Listed by 1 seedsman. Seeds tested: Salzer, 1904, 1905.

Description.—Plant very large, very spreading, with many runners lying loosely over ground, slender stemmed, green throughout, late, long in bearing period, moderately productive. Leaf very small, medium green. Flowers white. Snap pods uniform in size, short, curved, roundish to rectangular in cross section, of very irregular surface, very deeply creasebacked at both dorsal and ventral sutures, very light green, somewhat tough, stringy, of moderate fiber, of fair quality, quite free from anthracnose. Point of pod medium in length and slightly curved. Green shell pods borne mostly below foliage, never appreciably colored or splashed, full on outside between seeds, about 4⅛ inches long, and usually containing 6 seeds fairly close in pod. Dry pods easy to thrash. Dry seeds very small, proportionally short, roundish oval through cross section, generally well rounded at ends, straight at eye, solid white.

Comparison.—This little known and planted variety is one of the most interesting beans on trial, its pods being remarkable for their fleshiness, rectangular shape, and deeply creasebacked form, while the vines, although like a field bean in habit of growth, produce pods which are as suitable for snaps as many strictly garden beans, It is not yet known, however, whether the variety possesses any real value. It is certainly much inferior as a field bean to Navy Pea and other standard sorts and of no value for green shell beans. Its use, if any, seems to be for snap pods for home use. More like Navy Pea than any other, differing principally in fleshiness, shape of pods, and smaller vine. Stocks generally much mixed, especially with Navy Pea.

History.—Introduced in 1901 by John A. Salzer Seed Company, who state the variety came from New England.

Illustrations.—Cross section of snap pod is shown on Plate V, 6; snap pods on Plate X, 4; dry seeds are similar to White Creaseback (Pl. IV, 7), differing principally in much smaller size.

YELLOW CRANBERRY.

Listed by 5 seedsmen. Seeds tested: Rogers, 1906; Schlegel & Fottler, 1905.

Description.—Plant large, generally erect, without runners or spreading branches, thick stemmed, green throughout, late-intermediate in season, long in bearing, heavily productive. Leaf medium in size, dark green in color, of glossy surface, wide across leaflets. Flowers light pink. Snap pods uniform in size, long-medium, curved, oval through cross section, light green in color, brittle, of inappreciable string, of small fiber, of good quality, free from anthracnose. Point of pod medium in size and slightly curved. Green shell pods borne mostly below foliage, never appreciably colored or splashed, moderately depressed on outside between seeds, about 5 inches long, and usually containing 6 or 7 seeds crowded in pod. Dry pods easy to thrash. Dry seeds medium in size, proportionally short, roundish through cross section, invariably well rounded at ends, larger at one end than at other, rounded or full at eye, sliver from pod sometimes attached to eye, solid straw yellow in color, occasionally tinged in places with coppery yellow, but always with minute dark brownish area around eye.

Comparison.—This very old garden variety, which has now largely gone out of cultivation, is sometimes thought to be same as Long Yellow Six Weeks, but the true type as sold by careful seedsmen is a later variety and similar to Long Yellow Six Weeks only in color of seed, besides being an all-round variety, and suitable as either snaps or green shell beans for home or market, but not especially valuable in any other respect. Of about same usefulness as Warren Bush and similar to it in appearance, having the same habit of vine, but earlier in season and with shorter, narrower pods and differently colored seed.

History.—Cultivated in this country at least since 1820.

Illustrations.—Dry seeds are shown on Plate I, 5; snap pods are similar in shape to Round Yellow Six Weeks (Pl. XIII, 5), differing principally in being flatter and larger, or approaching more the shape of Warren Bush (Pl. IX, 2).

BUSH WAX-PODDED.

As already explained, this class of Kidney beans is used almost exclusively for snaps and rarely are the different varieties grown in large fields solely for their dry seeds. Wax beans are of comparatively recent development and the varieties are rapidly increasing in number.

ALLAN'S IMPERIAL WAX.

Listed by 4 seedsmen. Seeds tested: Allan, 1904, 1905; Kendel, 1905.

Description.—Plant medium size, erect, somewhat thick stemmed, without runners, wholly green, early-intermediate in season, of moderate bearing period, heavily to moderately productive. Leaf large, medium green. Flowers white. Snap pods very uniform in size, long, uniformly slightly curved at middle, flat, light yellow in color, usually more or less greenish tinged, occasionally almost solid light green, tough, very stringy, of much fiber, poor to medium in quality, fairly free from anthracnose. Point of pod long and straight or slightly curved. Green shell pods borne equally above and below foliage, never colored or splashed, slightly depressed between seeds, about 6⅛ inches long, and usually containing 6 seeds fairly close in pod. Dry pods very easy to thrash. Dry seeds large-medium in size, medium in length, oval through cross section, truncate or rounded at ends, generally straight at eye, white with golden brown area around eye, covering about one-sixth of bean.

Comparison.—Little known and planted. Exceedingly hardy, sure cropping, and bearing large pods of uniformly fine shape, but decidedly too stringy and tough for home use and often unattractive for market purposes because of tendency to be greenish tinged. No other wax variety except Golden-Eyed Wax is so often green in color. Most like Golden-Eyed Wax, differing principally in seed, greater productiveness, and much larger, more perfect pods; also similar to Scarlet Flageolet Wax and Davis Wax.

Synonym.—Salzer's Earliest Wax.

Confusing names.—Imperial White-Seeded and Jones's Imperial Wax are very different varieties from Allan's Imperial Wax.

History.—Listed in 1891 by Vaughan Seed Company, and originated by John H. Allan Seed Company.

Illustrations.—Ripe seeds are shown on Plate III, 3; snap pods on Plate VI, 4; cross sections of snap pods are similar to Detroit Wax (Pl. V, 16), differing principally in larger size and flatter shape.

BISMARCK BLACK WAX.

Listed by 5 seedsmen. Seeds tested: Buist, 1905; Keeney, 1904, 1905; Thorburn, 1903.

Description.—Plant medium in size, erect, without runners, somewhat thick stemmed, green throughout except generally slightly purple tinged in places on branches and flower stalk, especially at their nodes, early-intermediate in season, of moderate bearing period, heavily to moderately productive. Leaf medium in size, medium green in color. Flowers pink. Snap pods uniform in size, long to medium in length, round, moderately curved, medium yellow, brittle, stringy, of inappreciable fiber, of fair quality, fairly free from anthracnose for a wax variety. Point of pod long and slightly curved or straight. Green shell pods rarely appreciably colored, full on outside between seeds, about 5⅞ inches long, and usually containing 6 seeds crowded in pod. Dry pods fairly easy to thrash. Dry seeds medium in size, medium in length, roundish through cross section, rounded or truncate at ends, straight at eye, solid black in color.

Comparison.—Where quality is not important this little known and planted variety is the best of the round wax-podded beans for market gardening, but for home use or where quality is essential it is too stringy and tough podded to be generally recommended. Its superior qualities are reliability, hardiness, freedom from disease, and beautiful even color and shape. In these respects it is superior to German Black Wax and fully equal to such flat-podded sorts as Currie's Rustproof and Horticultural Wax.

Pods are more like German Black Wax than any other, differing principally in stringiness, toughness, greater size, longer pod point, and very even curvature at middle of pod, while vine is of about same habit as Davis Wax.

History.—Introduced in 1890 by Robert Buist Seed Company, who state the variety came from Germany.

Illustrations.—Snap pods are shown on Plate VII, 1; cross sections of snap pods are similar to Refugee (Pl. V, 12).

BLACK-EYED WAX.

Listed by 7 seedsmen. Seeds tested: Portland, 1906.

Description.—Plant large-medium, very erect, somewhat thick stemmed, without runners, wholly green, early, of short bearing period, moderately productive. Leaf medium in size, medium green in color. Flowers white. Snap pods uniform in size, of medium length, slightly curved, oval through cross section, deep yellow in color, brittle, stringless, without fiber, of good quality, somewhat subject to anthracnose. Green shell pods borne mostly above foliage, never splashed or colored, full on outside between seeds, about $4\frac{3}{4}$ inches long, and usually containing 5 or 6 seeds crowded in pod. Dry pods somewhat hard to thrash. Dry seeds medium in size and length, roundish oval through cross section, rounded or truncate at ends, generally full at eye, white with black area around eye and one end covering one-sixth of bean.

Comparison.—Very common fifteen years ago, but now almost gone out of cultivation. Excellent for home or market and one of the best for early planting. Except for being a few days earlier in season, the variety is of same usefulness as Golden Wax and differs from it principally in color of seed, and shorter, more curved pod, longer pod point, and larger, more open vine.

History.—Introduced in 1887 by Peter Henderson & Co. and W. Atlee Burpee & Co.

Illustrations.—Cross sections of snap pods are similar to Keeney's Rustless Golden Wax (Pl. V, 18), differing principally in being somewhat smaller and proportionally thicker; snap pods resemble Golden Wax (Pl. VI, 2).

BURPEE'S KIDNEY WAX.

Listed by 1 seedsman. Seeds tested: Burpee, 1906.

Description.—Plant large, without runners, but generally drooping with fruit-laden branches and spreading when fully grown, thick stemmed, green throughout, intermediate in seasons, of moderate to long bearing season, heavily to moderately productive. Leaf large, medium green, wide across leaflets, of rough surface. Flowers white. Snap pods uniform in size, very long, straight, oval-flat through cross section, medium yellow in color, brittle, stringless, without fiber, of excellent quality, fairly free from anthracnose. Point of pod long and much curved. Green shell pods borne equally above and below foliage, never splashed or appreciably colored, full on outside between seeds, about 6 inches long, and usually containing 7 seeds very crowded in pod. Dry pods often hard to thrash. Dry seeds large-medium, proportionally long, oval through cross section, rounded or truncate at ends, straight or incurved at eye, white, with mottling of pansy violet and maize yellow around eye and ends, generally covering one-sixth of bean.

Comparison.—Owing to incomplete trials, it seems impossible to give, at this time, the real usefulness and value of this new and as yet little known or cultivated variety. It is apparently a very valuable acquisition and possibly a great improvement over any of its class. Its pods are straighter, more even, more handsome, and of as good quality as either Wardwell's Kidney Wax or Round Pod Kidney Wax, and claimed by the introducer to be as early as and far more productive than the former, while in shape the pods are not quite as flat but fully as long as those of the latter.

History.—Introduced in 1906 by W. Atlee Burpee & Co.

Illustrations.—Dry seeds are similar to Wardwell's Kidney Wax (Pl. II, 17), differing principally in being less colored around eye; cross sections of snap pod resemble Mohawk (Pl. V, 17); snap pods resemble Horticultural Wax (Pl. VI, 3), differing principally in being longer.

BURPEE'S WHITE WAX.

Listed by 1 seedsman. Seeds tested: Burpee, 1905, 1906.

Description.—Plant large, of a dense, low, well-rounded habit, sometimes with heavy drooping branches, but never with real runners, very thick stemmed, wholly green, late, long in bearing, moderately to heavily productive. Leaf large, medium green, wide across leaflets, rough at surface. Flowers white. Snap pods uniform in size, long, straight, very flat, medium yellow, often tinged with green, very brittle, stringless, of inappreciable fiber, of good quality, fairly free from anthracnose. Point of pod short and curved. Green shell pods borne mostly below foliage, considerably depressed on outside between seeds, about 5⅞ inches long, and usually containing 6 seeds fairly separated in pod. Dry pods generally easy to thrash. Dry seeds large-medium, proportionally short, oval through cross section, well rounded at ends, straight or rounded at eye, solid white except minute area of yellow around eye.

Comparison.—New and as yet little known or planted. General usefulness and value not fully established; at least some reports state the variety to be very unreliable in season, productiveness, hardiness, and uniformity in size of pods, and others that it is superior to Davis or Wardwell's Kidney Wax for either market or home use. Its late season and fine quality are generally undisputed, and also its handsome appearance and productiveness when conditions are exactly favorable for a good growth. Similar to the old White Wax formerly listed by seedsmen, but of present day sorts it is as much like Wardwell's Kidney Wax as any.

History.—Introduced in 1905 by W. Atlee Burpee & Co., and originated by N. B. Keeney & Son, of Leroy, N. Y.

Illustrations.—Dry seeds are shown on Plate IV, 17; snap pods resemble Wardwell's Kidney Wax (Pl. X, 3), differing principally in being straighter, thicker, wider, and with longer pod point; cross sections of snap pods resemble Detroit Wax (Pl. V, 16), differing principally in being larger, thicker, and wider.

CHALLENGE BLACK WAX.

Listed by 44 seedsmen. Seeds tested: Ferry, 1900, 1902, 1904, 1905; Rogers, 1904, 1906; Gregory, 1898; Thorburn, 1897, 1901, 1902.

Description.—Plant very small, erect, somewhat thick stemmed, without runners or spreading branches, green throughout except generally slightly purple tinged in places on branches and flower stalks, especially at their nodes, very early, very short in bearing period, generally lightly productive. Leaf medium in size, medium green in color. Flowers pink. Snap pods somewhat variable in size, of medium to short length, generally much curved, roundish oval through cross section, medium yellow, very brittle, stringless, without fiber, of excellent quality, somewhat subject to anthracnose. Point of pod small-medium and either straight or slightly curved. Green shell pods borne mostly above foliage, never splashed or appreciably colored except sometimes a little purple at sutures near stem end, full between seed on outside of pod, about 4⅜ inches long, and usually containing 5 or 6 seeds crowded in pod. Dry pods very hard to thrash. Dry seeds medium in size and length, roundish through cross section, rounded or truncate at ends, straight at eye, sliver from pod occasionally attached to eye, solid black in color.

Comparison.—A well-known standard variety though probably not one of the twelve most largely grown bush sorts. Being earlier than any other wax bean and

probably earlier than any of the green-podded sorts, it often becomes very useful to market gardeners; but for home planting or for general use it not only lacks in productiveness and long bearing period but is also not nearly so reliable a cropper, so hardy, or so large and handsome podded as Prolific Black Wax, Pencil Pod Black Wax, and many others. In general usefulness and value, the variety is almost the same as Valentine Wax; but in appearance of vine and pod it is most like German Black Wax, differing principally in having much smaller pods and plants, in being much earlier in season, and less productive and shorter in bearing period.

History.—Introduced in 1891 by D. M. Ferry & Co. and said to have originated with Rogers Brothers, of Chaumont, N. Y., from a single plant found in a lot of beans imported from Germany.

Illustrations.—Snap pods and cross section are similar to Prolific Black Wax (Pl. VII, 4, and Pl. V, 8, respectively), differing principally in smaller size.

CRYSTAL WAX.

Listed by 18 seedsmen. Seeds tested: Burpee, 1901; Ferry, 1900, 1902, 1904–1906; Rogers, 1904; Wood, 1905.

Description.—Plant large-medium, low growing, very spreading in habit, of many runner-like branches lying loosely over ground, slender stemmed, green throughout, late, of moderate to long bearing period, moderately productive. Leaf small, medium green, wide across leaflets, of smooth surface. Flowers white. Snap pods somewhat variable in size, very short, curved, round or roundish rectangular through cross section, very deeply creasebacked, whitish or grayish green, brittle, stringy, of small fiber, of good quality, fairly free from anthracnose. Point of pod small-medium, straight or slightly curved. Green shell pods borne mostly well below foliage, generally more or less tinged with purple, never distinctly splashed, of very loose, flabby pod walls, about 3⅝ inches long, and usually containing 6 seeds well separated in pod. Dry pods extremely hard to thrash. Dry seeds very small, proportionally short, roundish oval through cross section, generally well rounded at ends, straight at eye, solid white.

Comparison.—Although known for a long time, this variety has always remained one of the lesser grown sorts. Its lack of popularity is due not only to its late season, spreading habit, and extremely small pods but also to its uneven and mixed character, nearly all stocks containing pods varying in shape from round to flat and plants very similar to or identical with Navy Pea. Of little practical value to gardeners but interesting to amateurs on account of peculiarly silvery or grayish white pods, no other variety except Golden Refugee having pods at all like it in color. The vine is similar in habit to Refugee and pods are somewhat the shape of Refugee Wax, though much shorter. Seeds so closely resemble Navy Pea that substitutes of cheaper seed are made by unscrupulous growers.

Synonyms.—Silver Wax, Cabbage Wax (of T. W. Wood & Sons), Silver Bean, Ice Bean.

History.—First listed by seedsmen in this country about 1886.

Illustrations.—Seeds are shown on Plate IV, 3; cross section of snap pod on Plate V, 7; snap pods are similar in shape to Yankee Winter (Pl. X, 4), differing principally in being much smaller and less rectangular through cross section; leaf is similar to Snowflake (Pl. XXIII, 5).

CURRIE'S RUSTPROOF WAX.

Listed by 95 seedsmen. Seeds tested: Currie, 1904, 1905; Ferry, 1900; Keeney, 1904, 1905; Philipps, 1903; Rogers, 1904, 1906; Sioux City, 1905; Thorburn, 1900, 1902; Wood, 1903; Young and Halstead, 1904.

Description.—Plant medium in size, very erect, somewhat thick stemmed, without runners or spreading branches, green throughout except generally slightly purplish tinged in places on branches and flower stalks, especially at their nodes, very early, short in bearing period, moderately to heavily productive. Leaf of medium size, medium green in color. Flowers pink. Snap pods very uniform in size, long, straight, flattish oval through cross section, light yellow, somewhat tough, very stringy, of much fiber, poor to medium in quality, somewhat subject to anthracnose. Point of pod medium in size and straight. Green shell pods borne mostly above foliage, never splashed or appreciably colored except for slight purplish color at stem ends, slightly depressed on outside between seeds, about 6 inches long, and usually containing 6 seeds crowded in pod. Dry pods easy to thrash. Dry seeds medium in size, proportionally long, oval through cross section, generally rounded at ends, straight at eye, solid black in color.

Comparison.—One of the five most largely grown wax sorts and in some sections planted to the exclusion of almost every other variety. Being early, productive, reliable, a fine shipper, and uniformly straight and handsome podded, it is a standard market gardener's sort in all parts of the country but is too tough and stringy for a good home variety. Of similar usefulness to Davis Wax, differing principally in color of seed and few days earlier season.

Synonyms.—Admiral Togo, California Black Wax, California Rustproof Wax, Currie's Black Wax, Eldorado Wax, Mill's Rustproof Wax.

History.—Introduced about 1885 by Currie Brothers, who write the variety came from a single plant found near Milwaukee in a field of Golden Wax.

Illustrations.—Ripe seeds are shown on Plate II, 27; snap pods on Plate VIII, 1, and cross section of snap pod on Plate V, 10.

DAVIS WAX.

Listed by 150 seedsmen. Seeds tested: Burpee, 1901; Ferry, 1900, 1904; Keeney, 1904-1906; May, 1897; Rogers, 1904, 1906; Thorburn, 1901, 1902.

Description.—Plant large-medium, very erect, somewhat thick stemmed, without runners, wholly green, early, of short bearing period, moderately productive. Leaf of medium size, medium green in color. Flowers white. Snap pods very uniform in size, very long, straight, flat, light yellow, tough, very stringy, of much fiber, of poor to medium quality, somewhat subject to anthracnose. Point of pod long, slightly curved. Green shell pods borne mostly above foliage, never colored or splashed, slightly depressed on outside between seeds, about 7 inches long, and usually containing 6 seeds crowded in pod. Dry pods easy to thrash. Dry seeds large-medium, slender, roundish through cross section, generally well rounded at ends, generally straight at eye, solid white, except minute area of yellow around eye.

Comparison.—One of the five most largely grown wax sorts and extensively planted in all parts of the country. Strictly a market gardener's variety and unsurpassed for shipping and uniformity in size and shape of pods, and, except for Hodson Wax, fully as handsome as any of the wax varieties. Especially useful because of white seeds, but too tough podded and stringy for home use. Once regarded as enormously productive and very disease resistant, but during the last few years much complaint has been heard of poor crops and diseased plants, its plantings for several years having fallen off greatly, especially in the South. Except for difference in color of seed, the variety is as much like Currie's Rustproof as any, differing principally in longer and flatter pods, larger vine, and a few days later season; also resembles Scarlet Flageolet Wax.

Synonyms.—Elgin White Wonder Wax, Prolific Everbearing Rustproof Wax, Tait's White Wax, Ventura Wonder Wax.

History.—Introduced in 1895 by D. M. Ferry & Co. and Wm. Henry Maule. Originated by Mr. Eugene Davis, of Grand Rapids, Mich.

Illustrations.—Ripe seeds are shown on Plate IV, 13; leaf on Plate XXIII, 8; snap pods and cross section of same resemble Currie's Rustproof Wax (Pl. VIII, 1, and Pl. V, 10, respectively), both differing principally in larger size and flatter shape.

DETROIT WAX.

Listed by 28 seedsmen. Seeds tested: Ferry, 1899, 1900, 1904, 1905; Thorburn, 1901, 1902.

Description.—Plant small, very erect, somewhat thick stemmed, wholly green, early, short in bearing period, lightly to moderately productive. Leaf medium in size, medium green in color, wide across leaflets, of smooth surface. Flowers white. Snap pods uniform in size, medium in length, straight, oval through cross section, often tinged with green, especially in poorly grown plants, tough, stringy, of moderate fiber, of medium quality, fairly free from anthracnose. Point of pod short-medium and straight. Green shell pods borne mostly above foliage, never splashed or colored, full on outside between seeds, about 5⅛ inches long, and usually containing 6 seeds crowded in pod. Dry pods fairly easy to thrash. Dry seeds medium in size, proportionally short, oval through cross section, rounded or truncate at ends, flat or rounded at eye, white with mottling of bluish black and maize-yellow around eye and ends, covering about one-fourth of bean.

Comparison.—Generally known but not extensively cultivated, at least not one of the twenty most largely planted sorts. Too stringy and tough podded for a good home variety and too short in bearing period and too unproductive for a good all-round sort, but a fairly good market garden variety for very early crops. Because a better shipper, a more certain cropper, more hardy, and more disease resistant, it is superior as a market gardening variety to Improved Golden Wax. Almost equal to Davis Wax and Currie's Rustproof Wax for market gardening. More like Improved Golden Wax than any other, differing principally in little larger vine, a few days later season, and flatter, larger, stringy pods of much fiber, but resembling it in compact, well-rounded habit and peculiarly smooth, widened, rather small leaflets.

History.—Introduced about 1885 by D. M. Ferry & Co.

Illustrations.—Ripe seeds are shown on Plate II, 6; cross section of snap pod on Plate V, 16; snap pods are similar in shape to Improved Golden Wax (Pl. VI, 1.)

DOUBLE-BARREL WAX.

Listed by 1 seedsman. Seeds tested: Landreth, 1905, 1906.

Description.—Plant large-medium in size, of a compact, bushy, well-rounded habit, without runners, rarely with drooping branches, thick stemmed, green throughout, late-intermediate in season, long to moderate in bearing period, moderately productive. Leaf large, medium green. Flowers pinkish white. Snap pods fairly uniform in size, long-medium, fairly straight, always broad through cross section, sometimes decidedly double barreled, often sharply constricted on outside between seeds, deep yellow in color, without greenish tingeing, extremely brittle, absolutely stringless, without fiber, of excellent quality, somewhat subject to anthracnose. Point of pod long-medium, thick, fairly regular in shape, slightly curved. Green shell pods borne mostly below foliage, depressed on outside between seeds, about 5¼ inches long, and usually containing 5 or 6 seeds very crowded in pod. Dry pods very hard to thrash. Dry seeds medium in size, proportionally short, roundish through cross section, generally well rounded at one end and larger and decidedly truncate at other, straight at eye, distinct line or ridge at back, sliver from pod occasionally attached to eye, solid brownish ocher in color except minute brown area around eye.

Comparison.—Little known and planted. Fully equal to Yosemite in quality and excellent for home gardening, but decidedly too tender, too variable in shape, and too

poor a shipper for market use. Most like Maule's Butter Wax, differing principally in color of seed, greater productiveness, larger, straighter, more uniform pods, and more compact vines, and therefore generally to be regarded as a much better variety.

History.—Introduced in 1901 by D. Landreth Seed Company.

Illustrations.—Dry seeds are shown on Plate II, 4; snap pods resemble Yosemite Wax (Pl. VIII, 2), differing principally in being almost straight and much shorter, decidedly smaller, less double barreled, and with much shallower constrictions between seeds; cross sections of snap pods also resemble same variety (Pl. V, 21 and 22).

GERMAN BLACK WAX BUSH.

Listed by 109 seedsmen. Seeds tested: Henderson, 1902; Johnson & Stokes, 1905; Keeney, 1905; Rogers, 1906.

Description.—Plant medium in size, erect when young, generally borne down with fruit-laden branches when fully grown, without runners, thick stemmed, green throughout except generally slightly purplish tinged in places on branches and flower stalks, especially at their nodes, early in season, of moderate bearing period, heavily to moderately productive, somewhat subject to anthracnose. Leaf medium in size, medium green in color. Flowers pink. Snap pods uniform in size, medium in length, generally more or less scimiter curved, round, medium yellow in color, very brittle, stringless, without fiber, of excellent quality, somewhat subject to anthracnose. Point of pod medium in length and either straight or slightly curved. Green shell pods borne equally above and below foliage, never appreciably colored, except for slight streaks of red along sutures at stem end, full on outside between seeds, about 4⅝ inches long, and usually containing 6 seeds very crowded in pod. Dry pods exceedingly hard to thrash. Dry seeds medium in size and length, roundish through cross section, rounded or truncate at ends, straight at eye, sliver from pod occasionally attached to eye, solid black in color.

Comparison.—One of the 5 most largely grown wax-podded varieties. Excellent for home or market. Especially useful because of high quality and general productiveness and reliability, not however as handsome and not usually as productive and reliable as Pencil Pod Black Wax nor so universally liked by experienced gardeners as Prolific Black Wax, while Golden Crown Wax is also considered superior by some because of its solid white seeds. Most like Prolific Black Wax, differing principally in somewhat later season, deeper yellow color, less tendency to reddish color at stem end of pod, larger leaves, and much coarser vines.

Synonyms.—Fuller's Black Wax, Fuller's Ringleader Black Wax, Griswold's Everbearing Wax, Salzer's Round-Podded Wax.

History.—First grown in this country about 1865, and probably the first of the wax-podded bush varieties.

Illustrations.—Snap pods and cross section are similar to Prolific Black Wax (Pl. VII, 4, and Pl. V, 8).

GOLDEN BEAUTY WAX.

Listed by 1 seedsman. Seeds tested: Darch & Hunter, 1902, 1904–1906.

Description.—Plant medium in size, of compact, well-rounded, bushlike habit, without runners or spreading branches, rather thick stemmed, green throughout, late-intermediate in season, of moderate bearing period, fairly productive. Leaf small-medium, of a peculiarly grayish green color, wide across leaflets, unusually flat, of remarkably smooth surface. Flowers white. Snap pods very uniform in size, short-medium, moderately curved, oval-round through cross section, medium yellow in color, brittle, stringless, without fiber, of good quality, somewhat subject to anthracnose. Point of pod short-medium, decidedly curved. Green shell pods borne well above

foliage, occasional branches remarkably high above plant, never splashed or colored, moderately depressed on outside between seeds, about $4\frac{3}{4}$ inches long, and usually containing 6 seeds crowded in pod. Dry pods sometimes hard to thrash. Dry seeds small, short, roundish oval through cross section, generally well rounded at ends, generally larger at one end than at other, rounded or full at eye, solid brownish ocher in color except minute brownish area around eye.

Comparison.—Little known and planted. A very handsome and excellent variety of same general usefulness as Golden Wax and more like it than any other. Worthy of extended trial, as in some conditions it proves superior to Golden Wax in hardiness and productiveness, and in the attractive, clear yellow color of its pods without the green tinge so often appearing in that variety

History.—Introduced about 1890 by the John H. Pearce Seed Company, now succeeded by Darch & Hunter.

Illustrations.—Cross section of snap pod resembles Keeney's Rustless Golden Wax (Pl. V, 18), differing principally in smaller and more oval shape; snap pods resemble Golden Wax (Pl. VI, 2), differing principally in shorter, more curved, not quite as flat pods and decidedly curved and somewhat longer pod point; leaf also resembles Golden Wax (Pl. XXIV, 2).

GOLDEN CROWN WAX.

Listed by 6 seedsmen. Seeds tested: Jones, 1904, 1905; Thorburn, 1901, 1902.

Description.—Plant medium in size, erect when young, generally borne down with fruit-laden branches when fully grown, without runners, thick stemmed, wholly green, early in season, of moderate bearing period, fairly productive. Leaf of medium size, medium green. Flowers white. Snap pods uniform in size, medium in length, generally more or less scimiter curved, round, medium yellow, very brittle, stringless, without fiber, of excellent quality, somewhat subject to anthracnose. Point of pod medium in length and straight or slightly curved. Green shell pods borne equally above and below foliage, never colored or splashed, full on outside between seeds, about $4\frac{5}{8}$ inches long, and usually containing 6 seeds very crowded in pod. Dry pods hard to thrash. Dry seeds medium in size, somewhat slender, roundish through cross section, truncate or rounded at ends, almost straight at eye, sliver from pod occasionally attached to eye, solid white, except minute area of yellow around eye.

Comparison.—Little known and planted, but on account of perfectly white seeds and absolute freedom from fiber and string, it makes an excellent sort for home or market, no other variety except Jones's Stringless Wax possessing all of these qualities. Its dry seeds are readily salable for baking beans; its snap pods are straighter and more handsome than German Black Wax and Jones's Stringless but not equal in these respects to those of Maule's Nameless Wax of 1906 and Round Pod Kidney Wax. Next to Jones's Stringless Wax, it is perhaps as much like German Black Wax as any, differing principally in color of seed and straighter, better filled pods.

History.—Introduced in 1899 by the originator, A. N. Jones, of Leroy, N. Y., and said to be a cross between Yosemite Wax and Ivory Pod Wax.

Illustrations.—Dry seeds are shown on Plate IV, 12; snap pods and cross sections of same are similar to Prolific Black Wax, (Pl. VII, 4, and Pl. V, 8, respectively), differing principally in greater size and straightness, and lighter yellow color of pods.

GOLDEN-EYED WAX.

Listed by 67 seedsmen. Seeds tested: Buckbee, 1897; Burpee, 1901, 1905; Ferry, 1899, 1900; Keeney, 1906; Rawson, 1897; Rogers, 1904, 1906; Thorburn, 1901, 1902; Wood, 1897.

Description.—Plant medium in size, very erect, somewhat thick stemmed, without runners, wholly green, early, short in bearing period, moderately productive. Leaf

medium in size, light green in color. Flowers white. Snap pods very uniform in size, long to medium, slightly curved, flat, light yellow, generally more or less greenish tinged, occasionally almost solid light green, tough, very stringy, of much fiber, poor to medium in quality, fairly free from anthracnose. Point of pod long and either straight or slightly curved. Green shell pods borne equally above and below foliage, never colored or splashed, slightly depressed between seeds, about 5½ inches long, and usually containing 6 seeds fairly close in pod. Dry pods easy to thrash. Dry seeds medium in size, proportionally long, oval through cross section, rounded or truncate at ends, generally straight at eye, solid white in color except small area of brownish ocher around eye.

Comparison.—Well known but not one of the twenty most largely grown varieties of the country. Decidedly too stringy and tough podded for home use, and often unsuited for market because of green-tinged pods. As described under Allan's Imperial Wax, this variety is not as well suited for market as some others; but of the two varieties Allen's Imperial Wax is by far the better, being much more productive, larger podded, more vigorous in growth, and having differently colored seed.

Synonyms.—Bolgiano's Sunshine Bush Wax, Sunshine Bush Wax.

History.—Introduced in 1889 by the late Aaron Low, of Essex, Mass., and originated by a Mr. Bartlett of Oshawa, Ontario, Canada.

Illustrations.—Ripe seeds are shown on Plate III, 1; snap pods resemble Allan's Imperial Wax (Pl. VI, 4), differing principally in smaller size; cross sections of snap pods resemble Detroit Wax (Pl. V, 16), differing principally in flatter shape.

GOLDEN WAX.

Listed by 81 seedsmen, besides 90 listing Improved Golden Wax and 26 listing Rustproof Golden Wax. Seeds tested: Buckbee, 1897; Burpee, 1897; Henderson, 1901; Farquhar, 1901; Keeney, 1906; McClure, 1903; Rogers, 1904, 1906; Schlegel & Fottler, 1901.

Description.—Plant small, very erect, somewhat thick stemmed, without runners, wholly green, very early, short in bearing period, lightly to moderately productive. Leaf medium in size, medium green in color, wide across leaflets, of smooth surface. Flowers white. Snap pods uniform in size, medium in length, straight, oval through cross section, deep yellow in color, often tinged with green, especially in poorly grown plants, somewhat brittle, stringless, of slight fiber, of good quality, somewhat subject to anthracnose. Point of pod short and straight or slightly curved. Green shell pods borne mostly above foliage, never splashed or colored, full on outside between seeds, about 5 inches long, and usually containing 5 or 6 seeds crowded in pod. Dry pods easy to thrash. Dry seeds medium in size and length, roundish oval through cross section, rounded or truncate at ends, flat or rounded at eye, white in color with mottling of dark violet and maize yellow around eye generally covering about one-half of bean.

Comparison.—A standard wax bean in all sections of the country, the plantings of the variety, together with those of Improved Golden Wax, being larger than those of any other single wax variety. A few days earlier than Improved Golden Wax, but according to Department reports not more subject to rust and anthracnose as sometimes claimed. Both varieties stand about equal as the best all-round and most reliable of the extra early wax sorts, both are suitable for either home or market, of nearly as good quality as the very best, generally fair shippers, and except for the greenish tinge, which sometimes appears under certain growing conditions, both are of handsome appearance, but for general crops both varieties are too short in season and much less productive than Keeney's Rustless Golden Wax or Pencil Pod Black Wax. Golden Wax differs from Improved Golden Wax principally in longer, narrower pods, smaller vine, and larger, lighter, mottled area around eye of dry seed.

Synonyms.—Ferry's Golden Wax, Isbell's Golden Butter, York State Wax.

History.—Introduced in 1876 by D. M. Ferry & Co. as Ferry's Golden Wax. Probably the same as the variety known about 1874 as York Dwarf Wax.

Illustrations.—Snap pods are shown on Plate VI, 2; a leaf is illustrated on Plate XXIV, 2; cross section of snap pod is similar to Keeney's Rustless Golden Wax (Pl. V, 18), differing principally in smaller and more nearly oval shape.

HENDERSON'S MARKET WAX.

Listed by 1 seedsman. Seeds tested: Henderson, 1902, 1904, 1905.

Description.—Plant large-medium, generally erect or occasionally spreading, somewhat thick stemmed, without runners, wholly green, early-intermediate in season, of moderate bearing period, heavily productive. Leaf of medium size, medium green. Flowers pinkish white. Snap pods uniform in size, long-medium, slightly curved, oval through cross section, medium yellow, somewhat brittle, very slightly stringy, of inappreciable fiber, medium in quality, fairly free from anthracnose. Point of pod medium in length and straight or slightly curved. Green shell pods borne equally above and below foliage, never colored or splashed, full on outside between seeds, about 6 inches long, and usually containing 6 or 7 seeds crowded in pod. Dry pods fairly easy to thrash. Dry seeds medium in size, proportionally short, roundish oval through cross section, truncate or rounded at ends, straight at eye, solid straw yellow in color, sometimes shading to copper yellow, always with minute brownish area around eye.

Comparison.—This little known and planted variety is an excellent all-round sort of same general usefulness and value as Wardwell's Kidney Wax. Its pods are slightly flatter, and distinctly straighter and longer in point than that variety, and though not so free from fiber, its plants are fully as productive and hardy, and possibly more certain croppers. Pods are less tough and stringy than Horticultural Wax, but similar in shape.

History.—Introduced in 1902 by Peter Henderson & Co., who write the seed came from Genesee County, N. Y.

Illustrations.—Dry seeds are shown on Plate II, 9; snap pods are similar to Horticultural Wax (Pl. VI, 3), differing principally in slightly more curved, narrower, and longer shape; cross sections of snap pods resemble Detroit Wax (Pl. V, 16).

HODSON WAX.

Listed by 8 seedsmen. Seeds tested: Harvey, 1902; Keeney, 1906; Young & Halstead, 1904, 1905.

Description.—Plant very large, without decided runners but with many outstretched branches lying loosely over the ground, thick-stemmed, wholly green, very late, long in bearing season, very heavily productive. Leaf of medium size, of very narrow and pointed leaflets, medium green. Flowers light pink. Snap pods uniform in size, very long, almost straight, flat, medium yellow, very tough, very stringy, of much fiber, poor to medium in quality, unusually free from anthracnose. Point of pod long and straight or slightly curved. Green shell pods borne mostly below foliage, never colored nor splashed, moderately depressed on outside between seeds, about 7½ inches long, and usually containing 6 to 8 seeds crowded in pod. Dry pods easy to thrash. Dry seeds large-medium, slender, roundish oval through cross section, generally well rounded at ends, slightly incurved at eye, purplish red freely splashed with pale buff.

Comparison.—New and as yet little known or cultivated but meeting with great favor in many sections of the country, especially in the South, where it has uniformly

proved to be the best and most reliable late wax sort for market gardeners, far surpassing all others in productiveness, hardiness, and large, handsome pods. In the extreme North its season is too late for the variety to be generally grown, while for home use its pods are decidedly too tough, even tougher, if anything, than Davis Wax. Except for color, its pods are same as Hodson Green Pod. Of the wax sorts its pods are most like Davis Wax, differing principally in their larger size and the mottled color of the seeds which resemble those of Red Valentine, but larger and longer.

History.—Introduced in 1902 by Harvey Seed Company, who state the variety came from a customer in whose possession it had been for a number of years.

Illustrations.—Dry seeds are shown on Plate I, 19; snap pods and cross section of same resemble in shape those of Currie's Rustproof (Pl. VIII, 1, and Pl. V, 10, respectively), both differing principally in much larger size and flatter shape.

HORTICULTURAL WAX.

Listed by 2 seedsmen. Seeds tested: Keeney, 1906; Rawson, 1903, 1905.

Description.—Plant large-medium in size, fairly erect, somewhat thick stemmed, without runners, green throughout, early-intermediate in season, of moderate bearing period, fairly to heavily productive. Leaf medium in size, medium green in color. Flowers pinkish white. Snap pods uniform in size, long-medium, straight, flattish oval through cross section, rich yellow, tough, stringy, of much fiber, poor to medium in quality, unusually free from anthracnose. Point of pod long and slightly curved or straight. Green shell pods borne equally above and below foliage, never colored or splashed, full on outside between seeds, about 5⅝ inches long, and usually containing 6 or 7 seeds crowded in pod. Dry pods easy to thrash. Dry seeds large-medium, proportionally short, oval through cross section, truncate or rounded at ends, straight at eye, purplish red, freely streaked with pale buff.

Comparison.—Although little known or planted, this is a much better variety for most purposes than similar sorts, such as Allan's Imperial Wax, Golden-Eyed Wax, and Detroit Wax. It surpasses all of these in uniformly handsome appearance, reliability, and productiveness, and, next to Allan's Imperial Wax, is the largest in size of pods. Strictly a market gardeners' bean, for which purpose it competes with Currie's Rustproof and Davis Wax, but pods are too tough for home use. Most like Allan's Imperial Wax, differing principally in color of seed and smaller, straighter, narrower pods, which are very similar to those of Henderson's Market Wax, while the seed is of almost same color as Red Valentine, but shorter and rounder in shape.

History.—Introduced in 1896 by W. W. Rawson & Co., who state it is a cross between Golden Wax and Dwarf Horticultural.

Illustrations.—Dry seeds are shown on Plate I, 16; snap pods on Plate VI, 3; cross sections of snap pods are similar to Detroit Wax (Pl. V, 16).

IMPROVED GOLDEN WAX.

Listed by 90 seedsmen, besides 81 listing Golden Wax, and 23 listing Rustproof Golden Wax. Seeds tested: Rogers, 1904, 1906; Thorburn, 1901, 1902.

Description.—Plant small, very erect, somewhat thick stemmed, without runners, wholly green, very early, short in bearing period, lightly to moderately productive. Leaf medium in size, medium green in color, wide across leaflets, smooth at surface. Flowers white. Snap pods uniform in size, medium in length, straight, oval through cross section, deep yellow in color, often tinged with green, especially in poorly grown plants, somewhat brittle, stringless, of little fiber, of good quality, somewhat subject to anthracnose. Point of pod short and straight. Green shell pods borne mostly above foliage, never splashed or colored, full between seeds on outside of pod, about

4½ inches long, and usually containing 5 or 6 seeds crowded in pod. Dry pods easy to thrash. Dry seeds medium in size, proportionally short, roundish oval through cross section, generally rounded at ends, slightly larger at one end than at other, rounded or full at eye, white with mottling of pansy violet and maize yellow around eye and ends, covering about one-fourth of seed.

Comparison.—General usefulness and value same as described for Golden Wax and, although exchanges of varieties can be made without objection, the two stocks should never be mixed if an even and satisfactory growth is to be obtained. After Golden Wax this variety is most like Detroit Wax, differing principally in being stringless, without fiber, less flat podded, and earlier in season.

Synonyms.—Golden Jersey Wax, Green's Golden German Wax, Grenell's Improved Golden Wax, Grenell's Rustproof Wax, New York Golden Wax, Rustproof Golden Wax.

History.—Introduced about 1884. Originated by W. H. Grenell, of Pierrepont Manor, N. Y.

Illustrations.—Ripe seeds are shown on Plate II, 5; snap pods on Plate VI, 1; cross section of snap pods are similar to Keeney's Rustless Golden Wax (Pl. V, 18), differing principally in smaller size and more oval shape.

JONES'S STRINGLESS WAX.

Listed by 38 seedsmen. Seeds tested: Breck, 1905; Ferry, 1903; Jones, 1903, 1904; Thorburn, 1901, 1902.

Description.—Plant medium in size, erect when young, generally borne down with fruit-laden branches when fully mature, without runners, thick stemmed, wholly green, early in season, moderate in bearing period, fairly productive. Leaf of medium size, medium green in color. Flowers white. Snap pods of uniform size, medium in length, generally more or less scimiter curved, round, medium yellow, very brittle, stringless, without fiber, of excellent quality, somewhat subject to anthracnose. Point of pod medium in length and either straight or slightly curved. Green shell pods borne equally above and below foliage, never colored or splashed, full on outside between seeds, about 4⅝ inches long, and usually containing 5 or 6 seeds very crowded in pod. Dry pods hard to thrash. Dry seeds medium in size, somewhat slender, roundish through cross section, truncate or rounded at ends, almost straight at eye, sliver from pod occasionally attached to eye, solid white, except minute area of yellow around eye.

Comparison.—Little known or cultivated. Of same general usefulness and value as Jones's Stringless Wax and sometimes hardly distinguishable from it, but careful tests have shown that Golden Crown is straighter and larger podded, somewhat more productive, more even and pure, and generally the better variety of the two. Also similar to German Black Wax, differing principally in seed and lighter yellow pods which have no tendency toward reddish tingeing at stem end of green shell pods.

Synonyms.—Hammond's Luscious Stringless Wax, Imperial White-Seeded Wax.

History.—Introduced in 1898 by several American seedsmen. Originated by A. N. Jones, of Leroy, N. Y., who states the variety was obtained by crossing Yosemite Wax with a white seedling of Ivory Pod Wax.

Illustrations.—Dry seeds are very similar to those of Golden Crown Wax (Pl. IV, 12), differing principally in being smaller than illustrations; snap pods and cross section of same are similar to Prolific Black Wax (Pl. VII, 4, and Pl. V, 8, respectively).

KEENEY'S RUSTLESS GOLDEN WAX.

Listed by 35 seedsmen. Seeds tested: Burpee, 1901; Ferry, 1900; Keeney, 1904–1906; Livingston, 1905; Thorburn, 1901, 1902.

Description.—Plant large, very spreading, with many long, drooping, almost runner-like branches lying loosely over ground, slender stemmed, green throughout, intermediate in season, very long in bearing period, heavily productive. Leaf small, grayish green in color, very smooth, generally short in length of petiole. Flowers white. Snap pods somewhat variable in size, medium in length, straight, oval-flat through cross section, medium yellow, very brittle, stringless, of inappreciable fiber, of good quality, unusually free from anthracnose. Point of pod short-medium, and either straight or slightly curved. Green shell pods generally borne well below foliage, never colored or splashed, full on outside between seeds, about 5¾ inches long, and usually containing 5 or 6 seeds crowded in pod. Dry pods easy to thrash. Dry seeds medium in size and length, roundish oval through cross section, rounded or truncate at ends, flat or rounded at eye, white in color, with mottling of dark violet and maize yellow around eye generally covering about one-half of bean.

Comparison.—Generally known among seedsmen but not extensively cultivated by gardeners. Although bearing uniformly handsome pods, and being more disease resistant, hardier, and more productive than any other wax bean of good quality, this variety has failed to become popular only because of its runner-like habit. In the young plants this peculiarity is almost as pronounced as in pole beans, but it ceases to develop after the plant sets pods and never becomes a serious obstacle to cultivation, while pods are fully as free from dirt and as well removed from the wet ground as most of the more erect sorts. Habit of vines similar to Refugee, and pods resemble Golden Wax more than any other, differing principally in being larger and wider. Seeds similar to Golden Wax, differing principally in larger size and flatter shape. Leaves quite different from other varieties and characterized by peculiarly smooth surface, grayish green color, and small size.

History.—Introduced in 1895 by several American seedsmen. Originated by N. B. Keeney & Son, of Leroy, N. Y., by whom it is described as a sport from Golden Wax.

Illustrations.—Cross section of a snap pod is shown on Plate V, 18; leaf on Plate XXIII, 1; snap pods resemble Golden Wax (Pl. VI, 2).

LEOPARD WAX.

Listed by 6 seedsmen. Seeds tested: Leonard, 1905, 1906.

Description.—Plant large-medium, very bushy and dense when young, generally burdened with fruit-laden branches and spreading when fully grown, very thick stemmed, green throughout, late-intermediate in season, of moderate to long bearing period, heavily to moderately productive. Leaf large, very dark green, of rough surface. Flowers light pink. Snap pods uniform in size, long-medium, moderately curved, flat, becoming roundish at green shell stage, light yellow in color, brittle, stringless, of inappreciable fiber, of good quality, fairly free from anthracnose. Point of pod short and slightly curved. Green shell pods borne mostly below foliage, never splashed or appreciably colored, full on outside between seeds, about 5½ inches long, and usually containing 5 or 6 seeds crowded in pod. Dry pods sometimes hard to thrash. Dry seeds large-medium, proportionally short, roundish oval through cross section, well rounded at ends, generally larger at one end than at other, rounded or full at eye, violet or bluish black in color except small area of white along back and one end.

Comparison.—Little known or planted. As Department trials of this variety were incomplete it is not possible to give its general usefulness and value at this time, only to state that it appears to be of same class as Burpee's White Wax and more like that variety than any other. In shape of pod it resembles a large, wide, immensely thick, Golden Wax.

History.—Introduced in 1905 by S. F. Leonard, who writes the seed came from a customer in Indiana.

Illustrations.—Seeds are shown on Plate II, 7; cross sections of snap pods resemble Keeney's Rustless Golden Wax (Pl. V, 18), differing principally in larger size; snap pods resemble Golden Wax (Pl. VI, 2), differing principally in being more curved and much larger in thickness and width.

LIVINGSTON'S HARDY WAX.

Listed by 1 seedsman. Seeds tested: Livingston, 1906.

Description.—Plant large, without runners, but generally drooping with fruit-laden branches and spreading when fully grown, thick stemmed, green throughout, intermediate in season, of moderate to long bearing period, heavily to moderately productive. Leaf large, medium green, wide across leaflets, and of rough surface. Flowers light pink. Snap pods somewhat variable in size, very long, generally decidedly scimiter curved, round, deeply creaseback ed, medium yellow, extremely brittle, absolutely stringless, wholly without fiber, of excellent quality, fairly free from anthracnose. Point of pod long, very curved, often irregular in shape. Green shell pods borne equally above and below foliage, never splashed or appreciably colored, full on outside between seeds, about 6 inches long, and usually containing 7 seeds very crowded in pod. Dry pods very hard to thrash. Dry seeds large-medium in size, proportionally long, roundish through cross section, truncate or rounded at ends, straight at eye, sliver from pod occasionally attached to eye, chocolate brown freely mottled and splashed with maize yellow.

Comparison.—New and as yet little known or cultivated. Same usefulness and value as Pencil Pod Black Wax and Round Pod Kidney Wax, differing from them in no important particular except color of seed.

History.—Introduced in 1906 by Livingston Seed Company, and originated by N. B. Keeney & Son, of Leroy, N. Y.

Illustrations.—Dry seeds are about the shape of Round Pod Kidney Wax (Pl. III, 9); cross section of snap pods resemble Prolific Black Wax (Pl. V, 8), differing principally in much larger size; snap pods are about same in shape and size as Pencil Pod Black Wax (Pl. VIII, 3).

MAULE'S BUTTER WAX.

Listed by 6 seedsmen. Seeds tested: Keeney, 1904.

Description.—Plant medium in size, somewhat spreading, generally with long, heavy, drooping branches, without real runners, thick stemmed, green throughout, late-intermediate in season, moderate in bearing period, lightly to moderately productive. Leaf large, medium green. Flowers white. Snap pods somewhat variable in size, medium in length, generally decidedly scimiter curved, always broad, decidedly double barreled through cross section, sharply constricted on outside between seeds, appearing as if drawn tight by a thread and separated in sections, deep yellow in color, extremely brittle, absolutely stringless, without fiber, of excellent quality, somewhat subject to anthracnose. Point of pod short, very thick, generally irregular in shape, slightly curved. Green shell pods borne mostly below foliage, depressed on outside between seeds, about 5 inches long, and usually containing 5 seeds very crowded in pod. Dry pods very hard to thrash. Dry seeds medium in size, proportionally short, roundish through cross section, generally well rounded at ends, straight at eye, white, except small mottled area of pansy violet and maize yellow around eye.

Comparison.—Little known or planted. Decidedly too tender for shipping and too variable in shape and size of pods to make a good appearance on the market, but excellent for home use or where tenderness, fleshiness, and the best quality are the desirable

points. Resembles Double Barrel Wax, but much superior to it in length, straightness, uniformity of pods, and in hardiness and productiveness of plant, differing also in color of seed, in less perfect pod point, and deeper depressions between seeds. After this variety it most resembles Yosemite Wax.

History.—Introduced in 1889 by Wm. Henry Maule, who states the variety originated with N. B. Keeney & Son, of Leroy, N. Y.

Illustrations.—Dry seeds are shown on Plate II, 18; cross section of snap pod on Plate V, 21; while snap pods resemble Yosemite Wax (Pl. VIII, 2), differing principally in seed and smaller size of pods.

MAULE'S NAMELESS WAX OF 1906.

Listed by 1 seedsman. Seeds tested: Rogers, 1905.

Description.—Plant large-medium, very erect when young, generally spreading and drooping with fruit-laden branches when old, without runners, wholly green, early, of moderate to long bearing period, heavily to moderately productive. Leaf large, medium green. Flowers white. Snap pods very uniform in size, long to medium, very straight, round, medium yellow, extremely brittle, absolutely stringless, without fiber, of excellent quality, fairly free from anthracnose. Point of pod long and straight. Green shell pods borne equally above and below foliage, never colored or splashed, full on outside between seeds, about 5½ inches long, and usually containing 6 seeds crowded in pod. Dry pods hard to thrash. Dry seeds medium in size and length, roundish through cross section, truncate or rounded at ends, generally straight at eye, white in color, with golden bronze around eye covering about one-sixth of seed.

Comparison.—New and as yet little known or planted. Evidently one of the best of the newer sorts and possibly the most handsome and best general-purpose wax-podded bean; at least in Department trials, its pods were straighter, more uniform in color and size, and more handsome than any other wax sort and fully as productive, early, and hardy as German Black Wax and Round Pod Kidney Wax. Excellent for either home or market. More like German Black Wax than any other, differing principally in color of seed and longer, straighter, better filled pods.

History.—Introduced in 1906 by Wm. Henry Maule and originated by Rogers Brothers, of Chaumont, N. Y.

Illustrations.—Dry seeds are similar to Allan's Imperial Wax (Pl. III, 3), differing principally in being smaller and round instead of flat; snap pods and cross section of same are similar to Prolific Black Wax (Pl. VII, 4, and Pl. V, 8, respectively), differing principally in larger size, and very straight pod and pod point.

MONARCH WAX.

Listed by 1 seedsman. Seeds tested: Darch & Hunter, 1904, 1906.

Description.—Plant medium in size, erect, without runners or spreading branches, somewhat thick stemmed, wholly green, late-intermediate in season, of moderate bearing period, moderately productive. Leaf medium in size, medium green in color. Flowers white. Snap pods uniform in size, long-medium, straight, round, depressed on outside between seeds, medium yellow, brittle, stringless, without fiber, of good quality, somewhat subject to anthracnose. Point of pod short-medium, straight, and thick. Green shell pods borne equally above and below foliage, never splashed or colored, very deeply depressed on outside between seeds, about 5⅝ inches long, and usually containing 5 or 6 seeds crowded in pod. Dry pods generally easy to thrash. Dry seeds large-medium, medium in length, flattish oval through cross section, well rounded at ends, straight at eye, solid white except small narrow strip of pansy violet at eye.

Comparison.—Little known or planted. As trials of this variety have not been complete, it is not possible at this time to give its general usefulness and value, only to state that it appears to be of same class as German Black Wax, differing principally in color of seeds, in much later season, and with pods very deeply and peculiarly depressed on outside between seeds.

History.—Introduced by Darch & Hunter in 1902.

Illustrations.—Dry seeds are shown on Plate II, 19; cross sections of snap pods resemble Prolific Black Wax (Pl. V, 8), differing principally in larger size; snap pods also resemble Prolific Black Wax (Pl. VII, 4), differing principally in being much larger through cross section, straight in shape, of much shorter, thicker pod point, and more depressed between seeds; green shell pods, however, are very different from above variety or any other here illustrated, the characteristic deep depressions between seeds being at this stage even more marked than in Round Yellow Six Weeks.

PENCIL POD BLACK WAX.

Listed by 46 seedsmen. Seeds tested: Burpee, 1902; Keeney, 1904–1906; Thorburn, 1901, 1902.

Description.—Plant large, without runners, generally drooping with fruit-laden branches and spreading when fully grown, thick stemmed, green throughout except generally slightly purplish tinged in places on branches and flower stalk, especially at their nodes; intermediate in season, of long to moderate bearing period, heavily to moderately productive. Leaf large, medium green, wide across leaflets, and of rough surface. Flowers pink. Snap pods somewhat variable in size, very long, frequently decidedly scimiter curved, round, deeply creasebacked, medium yellow, extremely brittle, absolutely stringless, absolutely without fiber, of excellent quality, fairly free from anthracnose. Point of pod long, very curved, often irregular in shape. Green shell pods borne equally above and below foliage, never splashed or appreciably colored, full on outside between seeds, about 6 inches long, and usually containing 7 seeds very crowded in pod. Dry pods very hard to thrash. Dry seeds large-medium in size, proportionally long, roundish through cross section, truncate or rounded at ends, straight at eye, sliver from pod occasionally attached to eye, solid black in color.

Comparison.—Extensively planted but perhaps not included among the twenty most largely grown bush varieties. Chiefly on account of its productiveness, high quality, and extremely long, handsome pods, this variety has been classed by some as not only the best wax variety for home use, but also the best all-round wax bean and an excellent sort for market gardening. All of these claims are probably true for some locations and the variety is undoubtedly one of the best wax beans for home use and for market gardening where the highest quality is desired, but as regards uniformity in size and shape of pods, straightness, and general attractiveness, the variety is generally surpassed by Maule's Nameless Wax of 1906, while Keeney's Rustless Golden Wax and Golden Crown Wax both surpass it in other qualities. For shipping and general market gardening this variety is not, however, nearly so desirable as some of the more uniformly shaped, hardier, tougher-podded, more productive sorts, such as Hodson Wax and Bismarck Black Wax. In appearance and general usefulness and value, this variety is about the same as Round Pod Kidney Wax. After this variety it is perhaps next most like German Black Wax, differing principally in decidedly longer, straighter pods, later season, greater productiveness, and much larger vine.

Synonyms.—Golden Scimiter Wax, Salzer's Giant Stringless Wax.

Confusing name.—Livingston's Yellow Pencil Pod Wax, a very different type of bean.

History.—Introduced in 1900 by Johnson & Stokes. Originated by N. B. Keeney & Son, of Leroy, N. Y.

Illustrations.—Dry seeds are shown on Plate II, 25; snap pods on Plate VIII, 3; while cross sections of snap pods are similar to Burpee's Stringless Green Pod (Pl. V, 13).

PROLIFIC BLACK WAX.

Listed by 72 seedsmen. Seeds tested: Keeney, 1904; Thorburn, 1901, 1902.

Description.—Plant medium in size, generally more or less spreading, sometimes with long outstretched branches, never with real runners, slender stemmed, green throughout, except generally purplish tinged in places on branches and flower stalks, especially at nodes, early-intermediate in season, long to moderate in bearing period, heavily to moderately productive. Leaf small, medium green, smooth at surface. Flowers pink. Snap pods uniform in size, medium short, generally more or less scimiter curved, round, medium yellow in color, very brittle, stringless, without fiber, of excellent quality, somewhat subject to anthracnose. Point of pod medium in length and slightly curved. Green shell pods borne mostly below foliage, never colored except streaked with red along sutures at stem end, full on outside between seeds, about 4¾ inches long, and usually containing 6 or 7 seeds very crowded in pod. Dry pods very hard to thrash. Dry seeds medium in size and length, roundish through cross section, rounded or truncate at ends, straight at eye, sliver from pod occasionally attached to eye, solid black in color.

Comparison.—One of the most largely grown wax-podded varieties. Excellent for either home or market and generally regarded by bean experts as more productive, hardier, more reliable, and generally superior to German Black Wax, with which variety it is often confounded, the two stocks being often interchanged and sold one for the other. Next to German Black Wax the variety is most like Golden Crown Wax, differing principally in color of seed, more slender, lighter yellow pods, and often in being reddish near stem end when fully grown.

Synonyms.—Cylinder Black Wax, Prolific German Black Wax, Improved Black Wax.

History.—Introduced in 1888 by several American seedsmen as Prolific German Black Wax. Variety originated from several plants selected by C. N. Keeney and W. W. Tracy, sr., in a field of German Black Wax in Genesee County, N. Y.

Illustrations.—Snap pods and a cross section of same are shown on Plate VII, 4, and Plate V, 8, respectively.

PURPLE FLAGEOLET WAX.

Listed by 3 seedsmen. Seeds tested: Keeney, 1903, 1905, 1906.

Description.—Plant large-medium, very erect, thick stemmed, without runners, green throughout except generally slightly purplish tinged in places on branches and flower stalks, especially at their nodes, intermediate in season, of moderate bearing period, moderately productive. Leaf of medium size, medium green in color. Flowers pink. Snap pods uniform in size, very long, curved, flat, deep yellow, often green tinged, tough, very stringy, of much fiber, of poor to medium quality, somewhat subject to anthracnose. Point of pod long and either straight or slightly curved. Green shell pods borne mostly above foliage, never splashed or appreciably colored, slightly depressed on outside between seeds, about 7⅜ inches long, and usually containing 7 seeds crowded in pod. Dry pods easy to thrash. Dry seeds large-medium, long, oval through cross section, rounded or truncate at ends, generally straight at eye, blackish purple, often tinged with brown.

Comparison.—Well known but not extensively planted. Same usefulness and value as described for Scarlet Flageolet Wax, and except for difference in color of seed same also in appearance of pod and plant.

Synonyms.—Perfection Wax, Violet Flageolet Wax.

History.—Type was first introduced in 1887 by W. Atlee Burpee & Co. as Burpee's Perfection Wax and later known also as Violet Flageolet Wax and Purple Flageolet Wax. Derived from the German variety listed about 1885 as Flageolet Wax.

Illustrations.—Snap pods may be described by reference to Currie's Rustproof Wax (Pl. VIII, 1), the chief difference being that pods are very much larger, flatter, and more curved than shown in illustrations of that variety, while surface is nearly as rough as that of Canadian Wonder (Pl. X, 2); cross sections of snap pods are similar to Detroit Wax (Pl. V, 16).

REFUGEE WAX.

Listed by 67 seedsmen. Seeds tested: Burpee, 1901; Ferry, 1900, 1903–1905; Henderson, 1901; Keeney, 1904, 1906; Rice, 1905, 1906; Rogers, 1904; Sioux, 1906; Thorburn, 1906.

Description of stringless type.—Plant large-medium, very spreading in habit, with many runner-like branches falling loosely over ground, slender stemmed, wholly green, intermediate-late in season, long in bearing period, heavily productive. Leaf small, light grayish green in color, very narrow across leaflets, and of very smooth surface. Flowers pink. Snap pods uniform in size, of medium length, slightly curved, round, light yellow in color, brittle, stringless, without fiber, of good quality, slightly subject to anthracnose. Point of pod medium in size, very much curved, almost hooklike in shape. Green shell pods borne mostly below foliage, generally sparingly splashed with faint purple, full on outside between seeds, about 4¾ inches long, and usually containing 5 seeds crowded in pod. Dry pods somewhat hard to thrash. Dry seeds medium in size, slender, roundish through cross section, truncate or rounded at ends, straight at eye, bluish black, fairly splashed with pale buff.

Description of stringy type.—Same as above, except more heavily productive, moderately curved pod point, stringy, of inappreciable fiber, with green shell pods generally 5 inches long and usually containing 5 or 6 seeds.

Comparison of stringless type.—Well known and largely cultivated, but not one of the twelve most largely grown sorts. A good all-round variety suitable for home or market, succeeding well in all sections, though apparently doing better at the North than at the South. Considerably later than most wax sorts and except Keeney's Rustless Golden Wax quite unlike any wax bean in habit of vine. Variety is given its name because of similarity in seed and vine to the green-podded Refugee variety. Pods more like Prolific Black Wax than any other, differing principally in color of seed and in more slender, faintly splashed pods with curved or hooklike pod point.

Comparison of stringy type.—Although not so extensively grown or of quite as good quality, this strain is nevertheless decidedly more hardy, productive, vigorous, larger podded, and better suited for market than the stringless type described above, but because of stringiness it is not always as well liked for home use. The two types are sometimes mixed by seedsmen, thereby producing such unevenness in size that the stronger growing plants of the stringy type often crowd out the weaker growing plants of the stringless type.

Synonyms of stringless type.—Bolgiano's Wax, Keeney's Refugee Wax, Livingston's Pencil Pod Wax, Profusion Wax, Thorburn's Refugee Wax.

Synonyms of stringy type.—Epicure Wax, Ferry's Refugee Wax.

History.—The first type of this bean, which was introduced in 1890 by J. M. Thorburn & Co. as Thorburn's Refugee Wax, is said to have been derived from Extra Early Refugee. The present stringless type, which is now used not only by J. M. Thorburn & Co., but also by most other seedsmen, was a selection from the old Thorburn stock made by N. B. Keeney & Son soon after the introduction of Thorburn's Refugee Wax. Most stocks of the present stringy type are derived from a selection made by D. M. Ferry & Co. from the old stringy type of J. M. Thorburn & Co.

Illustrations.—A leaf of the stringless type is shown on Plate XXIII, 4. The leaf of stringy type differs in being very slightly larger and not quite so narrow or pointed. Snap pods of the stringless type resemble Prolific Black Wax (Pl. VII, 4), differing principally in color of seed, and faintly splashed, more slender pods with decidedly hooklike pod points. The snap pods of the stringy type differ from those of stringless type principally in being larger, somewhat straighter, and without such decidedly curved pod points. Cross sections of both types are similar to Prolific Black Wax (Pl. V, 8).

ROGERS'S LIMA WAX.

Listed by 7 seedsmen. Seeds tested: J. C. McCullough, 1905; Maule, 1900, 1902; Rogers, 1904, 1905.

Description.—Plant of medium size, very spreading with many runner-like branches, drooping or creeping loosely over the ground, somewhat slender stemmed, wholly green, very late, long in bearing period, lightly productive. Leaf small, very light green, wide across leaflets, very flat, of very smooth surface, and somewhat resembling Lima leaves. Flowers white. Snap pods somewhat variable in size, very short, straight, except sometimes bent to one side, flat, very much depressed on outside between seeds, medium yellow, sometimes tinged with green, somewhat tough, stringy, of moderate fiber, of fair quality, fairly free from anthracnose. Point of pod thick, short, much curved, and generally imperfect. Green shell pods borne uniformly below foliage and close to ground, never colored or splashed, of very flabby and much depressed pod walls, about 4½ inches long, and usually containing about 5 seeds very much separated in pod. Dry pods easy to thrash. Dry seeds small, short, roundish oval through cross section, invariably well rounded at ends, very rounded or full at eye, decidedly larger at one end than at other, generally regular in shape, sometimes bulging out in places near eye, solid white.

Comparison.—Although largely advertised at the time of its introduction, this variety is now dropped from most seed lists, as it is now generally conceded to be of little practical value. It has never been planted except in an experimental way, and even among amateurs will probably be little grown. Undesirable because so late in season, spreading in habit, and unproductive, and so small, imperfect, and unattractive in size and shape of pods. Of some interest because of peculiar Lima-like pods, which make fairly good snaps so far as quality is concerned, but are very unsatisfactory in other respects and especially unproductive for green shell or dry beans. Pods very different from any other variety. Vines somewhat Lima-like in their very smooth stiff leaves.

Synonym.—Lima Wax.

History.—Introduced in 1896 by several American seedsmen. Originated by Rogers Brothers, of Chaumont, N. Y.

Illustrations.—Dry seeds are shown on Plate IV, 5; cross section of snap pod on Plate V, 19; leaf on Plate XXIII, 3; while snap and green shell pods are quite different from any of the illustrations shown in this bulletin.

ROUND POD KIDNEY WAX.

Listed by 46 seedsmen. Seeds tested: Ferry, 1902; Johnson & Stokes, 1901; Keeney, 1904–1906.

Description.—Plant large, very erect when young, generally drooping, with fruit-laden branches and spreading in habit when fully grown, without runners, thick stemmed, green throughout, with branches of distinct yellowish green shade, intermediate in season, long to moderate in bearing period, moderately productive. Leaf large, medium green in color, wide across leaflets, and of rough surface. Flowers white. Snap pods somewhat variable in size, very long, frequently decidedly scimi-

ter curved, round, deeply creasebacked, medium yellow, extremely brittle, absolutely stringless, entirely without fiber, of excellent quality, moderately free from anthracnose. Point of pod long, very curved, often irregular in shape. Green shell pods borne equally above and below foliage, never splashed or colored, full on outside between seeds, about 6 inches long, and usually containing 7 seeds very crowded in pod. Dry pods hard to thrash. Dry seeds large-medium, extremely slender and straight, roundish through cross section, rounded or truncate at ends, straight or slightly incurved at eye, solid white except small area of black around eye and one end.

Comparison.—Largely planted, but perhaps not included among the 20 most extensively grown bush beans. Excepting that its seeds have the superior quality of being almost white in color, this variety is very similar to Pencil Pod Black Wax and generally regarded as equally useful and valuable, though in our trials the growth of vine has not been as large, vigorous, or productive. Pods about same as those of Pencil Pod Black Wax.

Synonym.—Brittle Wax.

History.—Introduced in 1900 by Johnson & Stokes. Originated by N. B. Keeney & Son, of Leroy, N. Y.

Illustrations.—Dry seeds are illustrated on Plate III, 9; snap pods are similar to Pencil Pod Black Wax (Pl. VIII, 3) and cross section of snap pods to Burpee's Stringless Green Pod (Pl. V, 13).

SCARLET FLAGEOLET WAX.

Listed by 22 seedsmen. Seeds tested: Ferry, 1900; Johnson & Stokes, 1897.

Description.—Plant large-medium, very erect, thick stemmed, without runners, green throughout except generally slightly purplish tinged in places on branches and flower stalks, especially at their nodes, intermediate in season, of moderate bearing period, moderately productive. Leaf medium in size, medium green in color. Flowers pink. Snap pods uniform in size, very long, curved, flat, deep yellow, somewhat inclined to be greenish tinged, tough, very stringy, of much fiber, poor to medium in quality, somewhat subject to anthracnose. Point of pod long and either straight or slightly surved. Green shell pods borne mostly above foliage, never splashed or appreciably colored, slightly depressed on outside between seeds, about 7⅜ inches long, and usually containing 7 seeds crowded in pod. Dry pods easy to thrash. Dry seeds large medium, long, oval through cross section, rounded or truncate at ends, generally straight at eye, solid plum-violet in color.

Comparison.—Well known, but not extensively grown, although a great favorite in many places in the South. Decidedly too stringy and tough for home use and suitable only for market gardening. Except for Hodson Wax and Purple Flageolet Wax, its pods are larger than those of any other wax variety, and being of a coarse, rough surface and somewhat inclined to be greenish tinged its pods are not quite so handsome as Hodson Wax, nor are its plants so hardy, productive, and free from disease, although often more useful because of earliness. Differs from Purple Flageolet Wax only in color of seed; also resembles Davis Wax, differing principally in color of seed and in larger, longer, more greenish tinged pods.

Synonyms.—Crimson Flageolet Wax, Giant Dwarf Wax, King of Wax, Landreth's Scarlet Wax, Mammoth Red German Wax, Midsummer Wax, Red Flageolet Wax, Red German Wax, Rennie's Stringless Wax, Simmers's Early Giant Wax.

History.—Type was introduced in 1887 by D. Landreth Seed Company as Landreth's Scarlet Wax, but later became known also as Crimson Flageolet Wax, Red Flageolet Wax, and Scarlet Flageolet Wax. Derived from the German variety listed about 1885 as Flageolet Wax.

Illustrations.—Dry seeds are shown on Plate II, 26; snap pods may be described by reference to Currie's Rustproof Wax (Pl. VIII, 1), the chief difference being that pods are much larger, flatter, more curved, with surface nearly as coarse as Canadian Wonder (Pl. X, 2); cross section of snap pods are similar to Detroit Wax (Pl. V, 16).

SPECKLED WAX.

Listed by 1 seedsman. Seeds tested: Buckbee, 1905, 1906.

Description.—Plant large, erect, dense in habit when young, sometimes spreading when fully grown, always without runners, very thick stemmed, green throughout, very late, long in bearing period, heavily productive. Leaf large, dark green, rough at surface. Flowers pink. Snap pods uniform in size, long, straight, round, light yellow, somewhat tough, stringy, of slight fiber, fair in quality, fairly free from anthracnose. Point of pod long, straight, and slender. Green shell pods borne both above and below foliage, often lightly splashed with faint purple, quite depressed on outside between seeds, about 6 inches long, and usually containing 7 seeds very crowded in pod. Dry pods fairly easy to thrash. Dry seeds large-medium, long, roundish through cross section, rounded or truncate at ends, generally straight at eye, reddish buff in color, sparingly splashed with reddish purple.

Comparison.—Although catalogued as long ago as 1891, this variety has never been much grown, and is at present almost gone out of use. Its chief merits are straight, very handsome pods and immense crops under perfectly favorable conditions, but because crops are very late and often failures it has always remained unpopular. Pods as much like Bismarck Black Wax as any, differing principally in being splashed and very straight.

History.—Introduced in 1891 by W. C. Beckert as Beckert's Speckled Wax.

Illustrations.—Dry seeds are similar to the flat-podded type of Best of All (Pl. I, 18), the principal difference being larger size and more abundant splashing; snap pods and cross section of same resemble illustrations of Prolific Black Wax (Pl. VII, 4, and Pl. V, 8, respectively), differing principally in larger, straighter, and splashed color of pods.

VALENTINE WAX.

Listed by 43 seedsmen. Seeds tested: Burpee, 1901; Ferry, 1900; Rogers, 1904; Thorburn, 1901, 1902.

Description.—Plant very small, erect, somewhat slender stemmed, without runners or spreading branches, green throughout, very early, very short in bearing period, lightly productive. Leaf small, medium green. Flowers pinkish white. Snap pods fairly uniform in size, medium short, curved, roundish oval through cross section, medium yellow, brittle, stringy, of inappreciable fiber, of good quality, generally quite subject to anthracnose. Point of pod medium in length and either straight or slightly curved. Green shell pods borne mostly above foliage, never appreciably splashed or colored, full on outside between seeds, about 4½ inches long, and usually containing 6 seeds crowded in pod. Dry pods hard to thrash. Dry seeds medium in size, proportionally long, roundish through cross section, truncate or rounded at ends, straight at eye, generally irregular in shape, often twisted or bulged out in places, purplish red splashed with pale buff.

Comparison.—Generally advertised, but not now extensively grown, for although second in earliness among wax sorts it has been demonstrated during the last six years that the variety is decidedly lacking in hardiness, productiveness, reliability, and disease-resistant qualities, being even inferior in these respects to Challenge Black Wax, which variety it most resembles in appearance of pod and vine as well as in general usefulness and value. Pods somewhat larger, a little more slender, straighter,

and lighter yellow in color, and vines much smaller and more bushy than Challenge Black Wax. Differs from Red Valentine principally in color, stringlessness, and smaller size of pods, in well-rounded bushy vine, and wide instead of narrow leaflets, while seeds of the two varieties are of about same size and color.

Synonym.—Miller's Early Golden Stringless Wax.

History.—Introduced in 1885 by J. M. Thorburn & Co., who write the bean originated with T. V. Maxon, of Jefferson County, N. Y., from a sport found in Red Valentine.

Illustrations.—Dry seeds are similar to Red Valentine (Pl. I, 13); snap pods and cross section of same are similar to Prolific Black Wax (Pl. VII, 4, and Pl. V, 8, respectively), differing principally in being smaller in size, less round in shape, lighter yellow in color, and with seed of different color.

WARDWELL'S KIDNEY WAX.

Listed by 165 seedsmen. Seeds tested: Buckbee, 1897; Buist, 1905; Burpee, 1901; Denison, 1903; Ferry, 1899, 1900; Keeney, 1904–1906; May, 1897; Morse, 1906; Rogers, 1904, 1906; Thorburn, 1901, 1902; Wood, 1897.

Description.—Plant large-medium, fairly erect, thick stemmed, without runners, wholly green, early-intermediate in season, long to moderate in bearing period, moderately productive. Leaf large, dark green, of slightly rough surface. Flowers white. Snap pods uniform in size, long, generally turned back at stem end, flat, medium yellow, somewhat brittle, stringless, of little fiber, of good quality, much subject to anthracnose. Point of pod short and very straight. Green shell pods borne equally above and below foliage, never colored or splashed, full on outside between seeds, about $5\frac{7}{8}$ inches long, and usually containing 5 or 6 seeds crowded in pod. Dry pods fairly easy to thrash. Dry seeds large-medium, proportionally long, oval through cross section, rounded or truncate at ends, flat or incurved at eye, white with mottling of pansy violet and maize yellow around eye and ends, generally covering about one-fourth of bean.

Comparison.—One of the three most largely grown wax varieties and though largely planted in all parts of the country and a good all-round sort which is as well adapted for home use as for market it is not generally as free from disease or as certain a cropper as Henderson's Market, Currie's Rustproof, or Horticultural Wax, but when conditions are just right it is one of the most showy and productive of all the wax beans. Peculiar for its very heavy growth, very small pod point, and for a portion of its pods bending backward at stem end. Most like Horticultural Wax and Henderson's Market Wax, but of the common wax varieties it most resembles Golden Wax, differing principally in seed, in much larger size, in peculiar curvature of pod, in exceedingly small pod point, in later season, and in larger growth of vine.

Synonym.—Milliken's Wax.

History.—Introduced about 1885 by several American seedsmen and originated by a Mr. Wardwell, of Jefferson County, N. Y.

Illustrations.—Dry seeds are shown on Plate II, 17; snap pods on Plate X, 3; while cross sections of snap pods are somewhat flatter and larger than Currie's Rustproof (Pl. V, 10).

YOSEMITE WAX.

Listed by 54 seedsmen. Seeds tested: Burpee, 1900, 1901; Henderson, 1905; Keeney, 1904; Thorburn, 1897, 1902.

Description.—Plant large, without runners, generally with many drooping or heavy spreading branches, thick stemmed, green throughout, late-intermediate in season, long in bearing period, moderately productive. Leaf large, light green, wide across

leaflets, of rough surface. Flowers pink. Snap pods varying considerably in size, long, very scimiter curved, broad or double barreled through cross section so as to appear like two pods grown together, sharply constricted on outside between seeds, appearing as if drawn together by a thread and separated into sections, deeply crease-backed, deep yellow, extremely brittle, absolutely stringless, wholly without fiber, excellent in quality, fairly free from anthracnose. Point of pod very long, very thick, sometimes much curled and twisted. Green shell pods borne mostly below foliage, never appreciably splashed or colored, much depressed on outside between seeds, about 5 to 7 inches long, and usually containing 5 or 6 seeds well separated in pod. Dry pods very hard to thrash. Dry seeds large, proportionally medium in length, roundish through cross section, generally well rounded at ends, generally incurved at eye, irregular in shape, usually depressed at eye and either flattened or bulged out in other parts, solid black in color.

Comparison.—Generally advertised, but not much grown except in private gardens, being decidedly too tender podded for shipping and too variable in size, shape, and curvature of pod to make a good appearance on the market, besides generally a shy and uncertain bearer. Useful only as an exhibition sort or as a home variety, where extreme tenderness, fleshiness, and unquestionably fine quality is the principal object desired. Conceded everywhere to be the standard for quality in snap pods. Most like Maule's Butter Wax, differing principally in color of seeds and larger pods.

Synonym.—Hopkins' Everbearing Giant Wax.

History.—Introduced in 1889 by Peter Henderson & Co. and said to have originated from a single plant found in a field of White Wax Bush near Leroy, N. Y., by N. B Keeney & Son.

Illustrations.—Dry seeds are shown on Plate III, 26; cross sections of snap pods on Plate V, 21 and 22; and snap pods on Plate VIII, 2.

POLE GREEN-PODDED.

This class represents about the same range of color, shape, size, texture, and quality of seeds and pods as exists among varieties of the green-podded bush class. As in bush varieties many of the sorts are more useful for their dry seeds than for their snap pods.

ARLINGTON RED CRANBERRY POLE.

Listed by 3 seedsmen. Seeds tested: Farquhar, 1905.

Description.—Vine of large growth, of poor climbing habit when young, but doing well when once started, thick stemmed, much branched, green throughout, late-intermediate in season, long in bearing, heavily productive. Leaf small-medium in size, medium green in color. Flowers pink. Snap pods uniform in size, long-medium, fairly straight, often curved back at stem end, flat, light green, smooth, brittle, absolutely stringless, without fiber, of good quality, free from anthracnose. Point of pod short and very straight. Green shell pods often slightly purplish tinged along back and front, much depressed on outside between seeds, about 5⅝ inches long, and usually containing 7 or 8 seeds very crowded in pod. Dry pods easy to thrash. Dry seeds generally of medium size, but varying considerably, almost as wide as long, roundish through cross section, well rounded at ends, rounded or full at eye, solid plum-violet in color.

Comparison.—Little known or planted. Not equal for general use to Black Kentucky Wonder, Scotia, or Lazy Wife, but a fairly good all-round variety for snaps, green shell, or dry shell beans for either home or market, and where earliness is impor-

tant more satisfactory than these varieties. Because entirely stringless, it makes a better snap bean for home use than Red Cranberry, which variety it resembles more than any other. Pods also similar to Warren Bush and Yellow Cranberry Bush.

History.—Listed by American seedsmen at least since 1885.

Illustrations.—Green shell pods are similar to Red Cranberry Pole (Pl. XVIII, 3).

BLACK KENTUCKY WONDER POLE.

Listed by 1 seedsman. Seeds tested: J. C. McCullough, 1905.

Description.—Vine of very large growth, of fair climbing habit, much branched, very thick stemmed, generally green throughout, sometimes reddish at stems, late-intermediate in season, of very long bearing period, very heavily productive. Leaf very large, medium green in color. Flowers pink. Snap pods very uniform in size, very long, fairly straight, much inclined to turn back at stem end, round-oval through cross section, deeply creasebacked, dark green in color, of somewhat coarse surface, brittle, stringy, of small fiber, of good quality, unusually free from anthracnose. Point of pod small and slightly curved. Green shell pods generally reddish tinged, sometimes solid deep purplish red, always with black lines along dorsal and ventral sutures, much depressed on outside between seeds, much wrinkled, about $7\frac{1}{4}$ inches long, and usually containing 8 to 10 seeds somewhat separated in pod. Dry pods easy to thrash. Dry seeds of large-medium size, of medium length, flattish oval through cross section, generally well rounded at ends, straight at eye, solid black in color.

Comparison.—Little known and planted. For combination of productiveness, hardiness, and large pods this variety is unsurpassed by any other, the only sort approaching it in these respects being Scotia Pole. Excellent as snaps and very good as green or dry shell beans for home use, but because of purplish pods and black seeds it is unsuited as a green shell bean for market use. Most like White's Prolific, differing principally in color of seeds, season, productiveness, and larger, straighter, thicker pods. Differs from Kentucky Wonder not only in color of seed, but also in larger vine, later maturity, greater productiveness, and thicker pods.

History.—Listed by J. C. McCullough Seed Company at least since 1899 and apparently never listed by other seedsmen.

Illustrations.—Snap pods are shown on Plate XVII, 3; cross sections of snap pods are similar in shape to Kentucky Wonder Wax Pole (Pl. V, 26).

BROCKTON POLE.

Listed by 7 seedsmen. Seeds tested: Gregory, 1905.

Description.—Vine of large growth, of somewhat poor climbing habit when young, but doing well when once started, thick stemmed, moderately branched, wholly green, intermediate in season, of moderate to long bearing period, heavily productive. Leaf large-medium in size, dark green in color. Flowers pink. Snap pods fairly uniform in size, long, very straight, flat, dark green, of coarse surface, somewhat tough, stringy, of moderate fiber, of fair quality, fairly free from anthracnose. Point of pod extremely long, slender, straight. Green shell pods abundantly and brilliantly splashed with red, moderately depressed on outside between seed, about 8 inches long, and usually containing 5 or 6 seeds fairly separated in pod. Dry pods very easy to thrash. Dry seeds very large, long, oval through cross section, generally well rounded at ends, usually slightly incurved at eye, pale buff in color fairly splashed with dark reddish purple.

Comparison.—One of the lesser grown varieties and apparently cultivated only in New England, where the Horticultural class are the principal pole varieties grown for green shell beans. Ranks equally with Childs's Horticultural Pole as the best of the Horticultural class for strictly green shell beans. Of little value for snaps, but a

more certain cropper than Worcester Mammoth, more productive than Extra Early Horticultural Pole, and excepting Extra Early Horticultural and Golden Carmine-Podded Horticultural Pole the most handsomely splashed of all pole varieties. Not as productive, however, as Lazy Wife or Arlington Red Cranberry Pole or as generally useful. More like Childs's Horticultural than any other pole variety. Pods closely resemble Improved Goddard Bush, differing principally in flatter shape, longer pod point, and with seeds more separated in pod.

History.—Introduced in 1885 by the former Aaron Low Seed Company, and originated by a market gardener of Brockton, Mass.

Illustrations.—Dry seeds are illustrated on Plate I, 27; green shell pods on Plate XIX, 2.

BURGER'S STRINGLESS POLE.

Listed by 2 seedsmen. Seeds tested: Burpee, 1906; Vaughan, 1905.

Description.—Vine of small growth, of good climbing habit, little branched, somewhat slender stemmed for a pole bean, open in habit, green throughout, very early, of short bearing period, moderately to lightly productive. Leaf medium in size, medium green in color. Flowers white. Snap pods uniform in size, very long, moderately curved, oval-round through cross section, creaseback ed, dark green in color, of coarse surface, extremely brittle, stringless, without fiber, of very good quality, fairly free from anthracnose. Green shell pods never tinged or splashed except sometimes with black lines along dorsal and ventral sutures, much depressed on outside between seeds, much wrinkled, about 6¾ inches long and usually containing 8 or 9 seeds somewhat separated in pod. Dry pods hard to thrash. Dry seeds large-medium, medium in length, flattish oval through cross section, generally well rounded at ends, straight or incurved at eye, sliver from pod occasionally attached to eye, solid white.

Comparison.—New and as yet little known or cultivated. Ranks equally with Kentucky Wonder and White Creaseback as one of the best early varieties for snaps, but is sometimes claimed to be earlier, more productive, longer in bearing, and better in quality than either. Its absolute stringlessness certainly makes it superior in quality, and its white seed and solid dark green pods are also decided merits, but more experiments are necessary before stating whether it is superior in the other qualities claimed. Habit of vine about same as Kentucky Wonder Pole, but pods most resemble White's Prolific, differing principally in solid green color, rounder, straighter, more deeply creaseback ed shape, earlier season, and absolute stringlessness.

History.—First listed in 1903 by Vaughan Seed Company, who state that the variety is of German origin.

Illustrations.—Dry seeds are illustrated on Plate IV, 20; green shell pod and cross section of same resemble Kentucky Wonder Pole (Pl. XV, 2, and Pl. V, 25, respectively), differing principally in smoother, smaller, straighter, and somewhat flatter shape, besides differing in color of both seed and pod.

CHILDS'S HORTICULTURAL POLE.

Listed by 1 seedsman. Seed tested: Childs, 1905.

Description.—Vines of large growth, of poor climbing habit when young, but doing well when once started, thick stemmed, much branched, wholly green, intermediate to late in season, long in bearing, heavily productive. Leaf medium large in size, dark green in color. Flowers pink. Snap pods uniform in size, long, slightly curved at middle, flat, of somewhat coarse surface, dark green, barely brittle, stringy, somewhat tough, of moderate fiber, of fair quality, free from anthracnose. Point of pod long and curved. Green shell pods abundantly and distinctly splashed with brilliant red, moderately depressed on outside between seeds, about 6¾ inches long, and usually

containing 6 to 8 seeds somewhat separated in pod. Dry pods very easy to thrash. Dry seeds large-medium, proportionally short, roundish through cross section, generally well rounded at ends, flat or rounded at eye, pale buff freely splashed with reddish purple.

Comparison.—One of the minor varieties of the country and not largely planted except in New England, where the Horticultural class is used almost exclusively for green shell beans. Ranks equally with Brockton as the best of the Horticultural class for strictly green shell beans, but is of little value for snaps. More certain cropper than Worcester Mammoth, more brilliantly splashed and salable than London Horticultural, and more productive than Extra Early Horticultural; not, however, as productive as Lazy Wife or Black Kentucky Wonder or as generally useful. More like Brockton Pole than any other, differing principally in slightly later season, narrower pods, and shorter pod point.

History.—Introduced in 1891 by John Lewis Childs, who writes that the variety was discovered in a farmer's garden at North Jay, Me.

Illustrations.—Dry seeds are illustrated on Plate I, 10; green shell pods are similar to Brockton Pole (Pl. XIX, 2).

CONCORD POLE.

Listed by 2 seedsmen. Seeds tested: Emerson, 1904.

Description.—Vine of large-medium growth, of poor climbing habit when young, but doing well when once started, thick stemmed, much branched, green throughout, intermediate in season, long in bearing, moderately productive. Leaf small-medium in size, medium green in color. Flowers white. Snap pods very uniform in size, medium in length, curved at middle, flat, medium green, of decidedly coarse surface, somewhat tough, very stringy, of poor quality, free from anthracnose. Point of pod medium in size and very straight. Green shell pods never colored or splashed, much depressed on outside between seeds, about 5 inches long, and usually containing 6 or 7 seeds well separated in pod. Dry pods very easy to thrash. Dry seeds large-medium, proportionally short, roundish oval through cross section, truncate or rounded at ends, rounded or flat at eye, white at back, light buff in front with light mahogany markings around eye, the white color covering two-thirds of seed.

Comparison.—Little known or cultivated and of no great value, being decidedly too tough for snaps and too unattractive in appearance for good green shell beans. Its only recommendation, if any, seems to be hardiness and sure cropping qualities. More like Red Cranberry Pole than any other, differing principally in earliness and greater toughness, width, and flatness of pod; also similar to Lazy Wife.

Synonyms.—Big Sioux Pole, Hemisphere Pole, October Pole, Tall Sioux Pole.

History.—Introduced about 1865 and said to have originated at Concord, Mass.

Illustrations.—Dry seeds are illustrated on Plate I, 12; green shell pods on Plate XX, 2.

DUTCH CASE KNIFE POLE.

Listed by 111 seedsmen. Seeds tested: Burpee, 1901; Ferry, 1900; Fish, 1903, 1904; Lompoc, 1905; McClure, 1903; Morse, 1906; Thorburn, 1897, 1901, 1902, 1905.

Description.—Vine of large-medium growth, of good climbing habit, moderately branched, thick stemmed, wholly green, late-intermediate in season, of moderate to long bearing period, moderately to heavily productive. Leaf of medium size, of medium green color. Flowers white. Snap pods somewhat varying in size, very long, fairly straight, very flat, medium green in color, of somewhat coarse surface, very tough, very stringy, of much fiber, of very poor quality, free from anthracnose. Green shell pods solid green except black lines along sutures and occasionally splashed with

faint purple, very much depressed on outside between beans, about 8 inches long, and usually containing 7 or 8 seeds much separated in pod. Dry pods very easy to thrash. Dry seeds very large, proportionally medium in length, flattish through cross section, truncate or rounded at ends, decidedly incurved at eye, sometimes irregular in shape or bulged out on one side, solid white.

Comparison.—One of the six most largely planted Kidney pole beans. Most popular in the Middle West. Decidedly too tough and thin walled for snaps, but largely planted as a late green shell bean, for which use it ranks equally with Lazy Wife Pole and Worcester Mammoth. Except Early Giant Advance it is the flattest podded variety cultivated in the United States. More like Early Giant Advance than any other, differing principally in earliness and size of pods.

Synonyms.—Princess Pole, Corn Hill Pole.

History.—Cultivated in this country at least since 1820, and one of the oldest of the pole varieties.

Illustrations.—Dry seeds are illustrated on Plate IV, 24; cross section of snap pods on Plate V, 28; and green shell pod on Plate XX, 1.

EARLY GIANT ADVANCE POLE.

Listed by 1 seedsman. Seeds tested: Vaughan, 1905, 1906.

Description.—Vine of small growth, of good climbing habit, little branched, slender stemmed, very early, of short bearing period, lightly productive. Leaf of medium size, of medium green color. Flowers white. Snap pods variable in size, generally very long, straight, very flat, medium green in color, of somewhat coarse surface, very tough, very stringy, of much fiber, very poor in quality, free from anthracnose. Point of pod medium in size and slightly curved. Green shell pods solid green in color excepting black lines along dorsal and ventral sutures, and sometimes sparingly splashed throughout pod with faint purple, very much depressed on outside between seeds, about 7 inches long and usually containing 7 or 8 seeds much separated in pod. Dry pods very easy to thrash. Dry seeds very large, proportionally medium in length, flattish through cross section, truncate or rounded at ends, decidedly incurved at eye, sometimes irregular in shape, bulged out on one side, solid white.

Comparison.—New, little cultivated, and of but limited usefulness. Decidedly too thin walled and tough for snaps. Suitable only for green shell beans, and desirable for this use only because of its large white seed and extreme earliness. Too small-growing and unproductive as a general crop for green or dry shell beans. Most like Dutch Case Knife, the pods being indistinguishable from that variety, but vine differing principally in being less productive, much earlier in season, and much smaller in growth.

History.—Introduced in 1903 from Germany by J. C. Vaughan Seed Company.

Illustrations.—Dry seeds, green shell pods, and cross sections of snap pods are same as Dutch Case Knife (Pl. IV, 24; Pl. XX, 1; and Pl. V, 28, respectively).

EXTRA EARLY HORTICULTURAL POLE.

No longer listed by American seedsmen. Seeds tested: Ross, 1904–1906.

Description.—Vine of large-medium growth, of somewhat poor climbing habit when young, but climbing well when once started, somewhat thick stemmed, moderately branched, wholly green, early, of moderate bearing period, moderately to lightly productive. Leaf large-medium in size, dark green. Flowers pink. Snap pods very uniform in size, proportionally very short and wide, very straight, flat, dark green, of somewhat coarse surface, brittle, stringless, of small fiber, of fair quality, free from anthracnose. Point of pod long and very straight. Green shell pods generally abundantly and distinctly splashed with brilliant red, moderately depressed

on outside between seeds, about 5¼ inches long, and usually containing 5 seeds fairly separated in pod. Dry pods generally easy to thrash. Dry seeds large-medium, proportionally short, roundish oval through cross section, invariably well rounded at ends, rounded or full at eye, pale buff in color, freely splashed with purplish red.

Comparison.—One of the lesser grown pole varieties. Apparently cultivated only in New England. Decidedly the most handsomely splashed and earliest of the Horticultural class, but for a main crop variety either Brockton or London Horticultural Pole is much more productive and desirable for green shell beans than any other of the Horticultural class. Usable as snaps for only a short time and generally of little value for that purpose. Most like Brockton Pole, differing principally in season, size, absence of string, and shortness of point.

History.—Introduced in 1902 by Ross Brothers, who state the variety originated with gardeners in the vicinity of Worcester, Mass., where it is locally known as Little Gem and Little Wonder.

Illustrations.—Dry seeds are illustrated on Plate 1, 8, and green shell pods on Plate XV, 1.

KENTUCKY WONDER POLE.

Listed by 125 seedsmen. Seeds tested: Armsby, 1906; Ferry, 1898, 1900, 1903, 1905; Grenell, 1903; Lompoc, 1905, 1906; McClure, 1903; Rice, 1905, 1906; Routzahn, 1905; Thorburn, 1897, 1901, 1902.

Description.—Vine of small-medium growth, of good climbing habit, moderately branched, slender stemmed, open in habit, green throughout, very early, of short bearing period, moderately productive. Leaf medium in size, medium green in color. Flowers white. Snap pods uniform in size, very long, decidedly scimiter curved, much bent back at extreme stem end, much curved inward at tip end, round through cross section, deeply creasebacked, medium green in color, of very coarse and undulating surface, extremely brittle; slightly stringy, without fiber, of good quality, fairly free from anthracnose. Point of pod short and curved. Green shell pods early tinged with pink, somewhat splashed with red, very much depressed on outside between seeds, of much wrinkled and undulated surface, about 8¾ inches long, and usually containing 8 to 10 seeds fairly separated in pod. Dry pods very easy to thrash. Dry seeds of large-medium size, long, oval-triangular through cross section, rounded or slightly truncate at ends, straight or slightly incurved at eye, somewhat irregular in shape, sometimes bent on one side and bulged out on other, solid chamois in color quickly fading to dark fawn, always with minute reddish area around eye.

Comparison.—By far the best known and most generally cultivated pole variety. Largely and successfully grown in all parts of the country. Ranks equally with White Creaseback and Burger's Stringless as one of the best early pole snap beans for home or market, though as a main crop variety or for strictly green shell beans there are other more productive sorts. Variety easily identified by its peculiarly wrinkled surface and great length of pods, which are similar to Tennessee Wonder and also resemble Black Kentucky Wonder in respect to the wrinkled surface.

Synonyms.—American Sickle Pole, Archias's Improved Kentucky Wonder Pole, Eastern Wonder Pole, Georgia Monstrous Pole, Monstrous-Podded Southern Prolific Pole, Old Homestead Pole, Texas Prolific Pole.

History.—First listed by American seedsmen about 1875.

Illustrations.—A cross section of green shell pod is shown on Plate V, 25, and green shell pods on Plate XV, 2.

LAZY WIFE POLE.

Listed by 131 seedsmen. Seeds tested: Armsby, 1906; Burpee, 1900; Ferry, 1903; May, 1897, 1905, 1906; Rice, 1906; Thorburn, 1901, 1902, 1905; Wood, 1897.

Description.—Vine of large growth, of poor climbing habit when young, but doing well when once started, thick stemmed, much branched, wholly green, late, long in bearing, heavily productive. Leaf small, of medium green color. Flowers white. Snap pods uniform in size, long-medium, much curved back at stem end, otherwise very straight, very flat, much bulged out at seeds, light green, brittle, of smooth surface, stringless, of inappreciable fiber, of good quality, free from anthracnose. Point of pod short and very straight. Green shell pods never colored or splashed, much sunken between seeds, about 5¾ inches long, and usually containing 7 or 8 seeds crowded in pod. Dry pods fairly easy to thrash. Dry seeds of medium size, very short or almost as wide as long, roundish through cross section, generally well rounded at ends, decidedly larger at one end than at other, much rounded or full at eye, solid white.

Comparison.—One of the five most largely grown kidney pole varieties. The best general purpose late pole variety, excellent for either home or market. Of superior quality as snaps and on account of large white seeds and attractive pods excellent also for green or dry shell beans. For late snap beans it is surpassed only by Scotia and Black Kentucky Wonder, while it is best of all for late white-seeded green or dry shell beans. More like Arlington Red Cranberry than any other, differing principally in seed, and later, flatter, wider pods. Also similar to Concord Pole. Pods hardly distinguishable from Warren Bush.

Synonyms.—Maryland White Pole, White Cherry Pole.

History.—Name first used about 1882, though the type or one similar to it is said to have been in existence at least since 1810 under the name of White Cherry Pole and White Cranberry Pole. The old type was probably not stringless like the present day type.

Illustrations.—Dry seeds are shown on Plate IV, 16; green shell pods on Plate XV, 3.

LONDON HORTICULTURAL POLE.

Listed by 116 seedsmen. Seeds tested: Ferry, 1903; Fish, 1903–1905.

Description.—Vine of large growth, of poor climbing habit when young, but climbing well when once started, thick stemmed, much branched, wholly green, late, long in bearing, heavily productive. Leaf of medium size, dark green. Flowers pink. Snap pods uniform in size, long, straight, flat, becoming oval at green shell stage, very dark green, of smooth surface, brittle, stringless, of small fiber, of good quality, fairly free from anthracnose. Point of pod medium in size and straight. Green shell pods abundantly and distinctly splashed with purplish red but not until very late, moderately depressed on outside between seeds, about 6 inches long, and usually containing 6 or 7 seeds fairly close in pod. Dry pods fairly easy to thrash. Dry seeds large-medium, proportionally very short, roundish oval through cross section, generally truncate at ends, rounded or full at eye, pale buff in color freely splashed with purplish red.

Comparison.—One of the five most largely grown Kidney pole beans. Decidedly the best of the Horticultural varieties for general use and almost equal to Lazy Wife as a general-purpose late snap and green shell bean suitable for home or market. More reliable than Worcester Mammoth and much better as snaps than Childs's Horticultural or Brockton Pole, but for green shell beans its pods are not nearly as brilliantly splashed and handsome. More like Childs's Horticultural than any other variety now listed by American seedsmen, differing principally in season, color of splashing, and freedom from string.

Synonyms.—Horticultural Cranberry Pole, Horticultural Pole, Speckled Cranberry Pole, Wren's Egg Pole.

History.—Name has been in common use in this country at least since about 1860.

Illustrations.—Dry seeds are illustrated on Plate I, 6, green shell pods are intermediate in shape between those of Concord Pole (Pl. XX, 2) and Red Cranberry Pole (Pl. XVIII, 3), and splashed about the same as Brockton Pole (Pl. XIX, 2).

MISSOURI WONDER POLE.

Listed by 2 seedsmen. Seeds tested: Field, 1904, 1905.

Description.—Vine of large growth, of good climbing habit, much branched, thick stemmed, wholly green, late, long in bearing, very heavily productive. Leaf small-medium in size, medium green in color. Flowers white. Snap pods very uniform in size, long, much curved, flat, medium green in color, of smooth surface, very tough, very stringy, of much fiber, of poor quality, very free from anthracnose. Point of pod medium in size and straight. Green shell pods generally solid light green, sometimes splashed with faint red, much depressed between seeds, about 5¾ inches long, and usually containing 7 seeds well separated in pod. Dry pods very easy to thrash. Dry seeds medium in size, medium in length, flattish oval through cross section, rounded or truncate at ends, generally slightly incurved at eye, pinkish drab in color, striped and spotted with tan brown, and with minute reddish area around eye.

Comparison.—Little known and planted and of but limited usefulness. Decidedly too tough and thin walled for good snaps and too small seeded, narrow podded, and unattractive for good green shell beans. Its usefulness, if any, seems to be for planting among corn for dry beans, but even for this purpose the white-seeded Royal Corn and Lazy Wife are generally far better varieties, though perhaps not always so productive and hardy. Most like Royal Corn and Southern Prolific, differing from former principally in much earlier season, shorter, flatter shape, and faintly splashed color when old. Pods quite similar in shape to Long Yellow Six Weeks Bush.

History.—Introduced in 1903 by several western seedsmen.

Illustrations.—Snap pods are similar in shape to Long Yellow Six Weeks (Pl. X, 1) and cross sections of snap pods to Mohawk (Pl. V, 17).

POWELL'S PROLIFIC POLE.

Listed by 3 seedsmen. Seeds tested: Livingston, 1898–1902, 1905.

Description.—Vine of very large growth, of good climbing habit, much branched, very thick stemmed, often purplish tinged on stems, very late, very long in bearing period, very heavily productive. Leaf large-medium in size, medium green in color. Snap pods very uniform in size, long, fairly straight, round, deeply creasebacked, light green in color, of very smooth and glossy surface, extremely brittle, stringy, of small fiber, of good quality, free from anthracnose. Point of pod short and curved. Green shell pods varying in color from almost solid green to almost solid purple, full on outside between seeds, about 5⅜ inches long, and usually containing 8 or 9 seeds very crowded in pod. Dry pods very easy to thrash. Dry seeds small, proportionally long, roundish oval through cross section, rounded or truncate at ends, straight at eye, solid black to madder brown in color.

Comparison.—Little known and planted. The latest in season, the largest in growth, and where full crops can be obtained, probably the first in productiveness among Kidney pole beans. Decidedly too late for general cultivation at the North, but excellent at the South, where it makes the best show or exhibition variety, so far as large growth and immense productiveness are concerned. Produces excellent snap beans for either home or market, but for general reliability and usefulness Scotia, Black Kentucky Wonder, and Lazy Wife are much better as late sorts for most parts of the country. Pod and vine very similar to the late round-podded plants often found in stocks of White Creaseback; also similar to Scotia and the fleshy round-podded type of Southern Prolific.

History.—Introduced in 1887 by A. T. Cook and originated by E. P. Powell.

Illustrations.—Dry seeds are illustrated on Plate II, 16, and cross section of snap pod on Plate V, 22, white green shell pods are same as White Creaseback Pole (Pl. XIX, 1) except larger.

RED CRANBERRY POLE.

Listed by 8 seedsmen. Seeds tested: Breck, 1905; Schlegel & Fottler, 1904.

Description.—Vine of very large growth, of poor climbing habit when young, but doing well when once started, thick stemmed, much branched, wholly green, late-intermediate in season, long in bearing, heavily productive. Leaf small-medium in size, medium green in color. Flowers pink. Snap pods uniform in size, long-medium, straight except curved back at stem end, flat, light green, of smooth surface, brittle, moderately stringy, of small fiber, of medium to good quality, free from anthracnose. Point of pod short and very straight. Green shell pods mostly solid green, often slightly purplish tinged along sutures, much depressed on outside between seeds, about 5⅜ inches long, and usually containing 7 or 8 seeds quite crowded in pod. Dry pods fairly easy to thrash. Dry seeds medium in size, but varying considerably, almost as wide as long, roundish through cross section, well rounded at ends, rounded or full at eye, solid plum-violet in color.

Comparison.—About 1875 it was one of the most largely grown pole varieties, but to-day is only little known and planted. Lazy Wife is much more desirable as a general-purpose late variety, and Black Kentucky Wonder, Scotia, and Arlington Red Cranberry are much preferable for strictly snap pods. Except that pods are stringy, the variety is hardly distinguishable from Arlington Red Cranberry, differing principally in being somewhat more hardy and productive and a few days earlier in season. Also similar to Lazy Wife and Concord Pole, and pod closely resembles Warren Bush and Yellow Cranberry.

History.—Cultivated in this country at least since 1820 and one of the oldest pole varieties.

Illustrations.—Green shell pods are shown on Plate XVIII, 3.

ROYAL CORN POLE.

Listed by 2 seedsmen. Seeds tested: Livingston, 1904, 1906.

Description.—Vine of very large growth, of fair climbing habit, much branched, thick stemmed, green throughout, late, long in bearing, heavily productive. Leaf of medium size, of medium green color. Flowers white. Snap pods somewhat variable in size, extremely long and slender, very curved, especially at tip end, generally much twisted, oval through cross section, becoming flat at green shell stage, medium green, of fairly smooth surface, barely brittle, very stringy, of much fiber, of fair quality, very free from anthracnose. Point of pod fairly straight and of medium size. Green shell pod with black lines along dorsal and ventral sutures, otherwise never colored or appreciably splashed, somewhat depressed on outside between seeds, often with missing seeds, sometimes imperfect at tip, about 8 inches long, and usually containing 8 or 9 seeds somewhat separated in pod. Dry pods easy to thrash. Dry seeds small, proportionally medium in length, oval through cross section, rounded or slightly truncate at ends, almost straight at eye, solid white.

Comparison.—New and valuable but as yet little known or cultivated. Possibly too late in season for always ripening full crops at the extreme North, but excellent as a late variety for other sections, especially the South, its white seed particularly commending it as a late sort where colored seed is objectionable. Being earlier and more productive the variety is generally more satisfactory for snaps than White Sickle

Pole, but seeds are somewhat too small to make a good green shell variety. Most like White Sickle, differing principally in being earlier, more productive, more stringy, and flatter podded.

Synonyms.—Livingston's Royal Corn, Schwill's Royal Corn.

History.—Introduced in 1898 by Livingston Seed Company, as Livingston's Royal Corn.

Illustrations.—Dry seeds are illustrated on Plate IV, 8, and green shell pods on Plate XX, 3.

SCOTIA POLE.

Listed by 3 seedsmen. Seeds tested: Harris, 1902, 1904, 1905; Schwill, 1905.

Description.—Vine of large growth, of good climbing habit, much branched, thick stemmed, generally dark purplish tinged in places on stems, late-intermediate in season, very long in bearing, very heavily productive. Leaf small-medium, very smooth, dark green, often somewhat purplish tinged. Flowers pink. Snap pods uniform in size, very long, very straight, round, exceedingly large in diameter, deeply crease-backed, dark green, sometimes purplish tinged, of exceedingly smooth and glossy surface, fairly brittle, of very hard flesh, stringy, of moderate fiber, of good quality, very free from anthracnose. Point of pod very short and curved. Green shell pods generally tinged with purple, sparingly splashed with purplish red, very full on outside between seeds, about 7¼ inches long, and usually containing 8 to 10 seeds very crowded in pod. Dry pods fairly easy to thrash. Dry seeds small-medium in size, proportionally short, oval through cross section, well rounded at ends, straight at eye, very light mottled putty in color and also colored throughout with long circular strips of blackish olive green and always with minute yellow ocher area around eye.

Comparison.—Little known and cultivated. With Black Kentucky Wonder it possesses the distinction of being one of the best two late pole varieties as snaps for home or market, Black Kentucky Wonder being somewhat preferable for home use on account of its better quality. Both varieties are unsurpassed by any of their class in remarkable combination of productiveness, hardiness, and exceedingly thick, immense, handsome pods. Available for snaps longer than any other variety and ripens early enough to mature good crops at the North. A most reliable and showy sort for exhibition purposes. Color of pod, vine, and leaf same as Tennessee Wonder but quite different from that variety in other respects. Easily identified by its small leaves, purplish color, and thick, straight pods. More like Powell's Prolific than any other variety. Pods similar to White Creaseback, differing principally in purplish color and larger size.

History.—Introduced in 1892 by Jos. Harris Company, who state that the seed came from a customer in eastern New York.

Illustrations.—Cross section of snap pod is shown on Plate V, 15, and snap pods on Plate XVII, 2.

SOUTHERN PROLIFIC POLE.

Listed by 38 seedsmen. Seeds tested: Burpee, 1901; Ferry, 1900, 1906; Fish, 1903, 1904; Johnson & Stokes, 1906; McClure, 1903; Rogers, 1906; Thorburn, 1901, 1902, 1905, 1906; Wood, 1897.

Description of long, flat-podded type.—Vine of very large growth, of good climbing habit, much branched, very thick stemmed, often purplish tinged at ends, late, long in bearing, very heavily productive. Leaves small, dark green. Flowers white. Snap pods uniform in size, long, flat, becoming oval at green shell stage, of rather dull grayish green color, of smooth surface, very tough, very stringy, of much fiber, of poor quality, very free from anthracnose. Point of pod medium in size and slightly curved. Green shell pods often purplish tinged, sometimes almost solid purple, moderately

depressed between seeds, about 6 inches long, and usually containing 8 to 10 seeds somewhat close in pod. Dry pods easy to thrash. Dry seeds small-medium, long, roundish or oval through cross section, rounded or truncate at ends, straight at eye, varying in color from solid dark fawn in some beans to light fawn in others.

Description of short fleshy-podded type.— See comparison below.

Comparison of long and short-podded types.— About 1880 this bean was one of the best known and most generally cultivated of the pole varieties, but to-day is only little planted, and the variety, once brittle and fleshy-podded and excellent for snaps, has degenerated into a mixture of tough-podded beans, generally containing more fiber and less suited for snaps than any other pole variety; at least, so far as our experiments have been carried, no samples have shown any considerable number of the old fleshy pods of twenty years ago. Most of present day stocks seem to consist largely of the long flat-podded type described above or of pods about the shape of Navy Pea but about twice as large, and more resembling Virginia Cornfield than any other pole variety. Some present day stocks also contain a shorter and less flat-podded type, somewhat resembling the old brittle-podded type, but decidedly too tough and stringy for use as snaps, somewhat oval through cross section, and inclined to be very reddish tinged at green shell stage. Besides above differences in pod, present day stocks vary considerably also in the color of seeds.

Synonym of long flat-podded type.—Willing's Pride Pole.

History.—Listed in 1873 by D. Landreth Seed Company, although probably cultivated in the South before that time.

Illustrations.—Light colored seeds are illustrated on Plate II, 2; cross section of the old, true, fleshy-podded type on Plate V, 1; cross section of present long, flat-podded type on Plate V, 2; green shell pods of the long, flat-podded type, the present short, tough-podded type, and the old, short, fleshy-podded type on Plate XVI, 1, 2, and 4, respectively.

SPECKLED CUT SHORT POLE.

Listed by 101 seedsmen. Seeds tested: Ferry, 1898, 1900; Fish, 1903, 1904; McClure, 1903; Thorburn, 1897, 1902.

Description.— Vine of moderate to large growth, of good climbing habit, moderately branching, somewhat thick stemmed, wholly green, intermediate-late in season, long in bearing, heavily productive. Leaf small-medium in size, medium green in color. Flowers white. Snap pods very uniform in size, very short, very straight, decidedly bulged out in places, flat, becoming oval at green shell stage, medium green in color, of smooth surface, somewhat tough, very stringy, of moderate fiber, medium to poor in quality, fairly free from anthracnose. Point of pod short and very straight. Green shell pods reddish tinged, much depressed on outside between beans, about 4 inches long, and usually containing 7 seeds very crowded in pod. Dry pods very easy to thrash. Dry seeds small, very short, sometimes wider than long, oval through cross section, decidedly truncate and generally more obliquely than squarely so, invariably straight at eye, irregular and variable in shape, dingy gray in color, dotted or completely covered with purplish red around eye, at back, and one end.

Comparison.—One of the 6 most largely cultivated Kidney pole beans. Probably more largely used for planting among corn than any other variety and apparently useful only for this purpose. Pods and seeds much too small and unattractive as green shell beans for sale in market or for general use. Variety does not closely resemble any other pole bean, but in shape and color of pods it is perhaps as much like Lazy Wife as any, although much smaller. Pods also similar to those of Navy Bush, differing principally in color, size, and with seeds more crowded in pod.

Synonyms.—Corn Hill Pole, Cornfield Pole, Cut Short Pole.

History.—Type apparently first known in this country as Corn Bean, later as Corn Hill, and within the last ten or twenty years as Speckled Cut Short. The name Corn Hill has been in use at least since 1835.

Illustrations.—Dry seeds are illustrated on Plate I, 1; green shell pods on Plate XVII, 1 and 4; cross section of snap pod is similar to Navy Pea (Pl. V, 3), differing principally in larger size.

TENNESSEE WONDER POLE.

Listed by 1 seedsman. Seeds tested: Landreth, 1905.

Description.—Vine of small-medium growth, of good climbing habit, few to moderately branched, slender stemmed, open in habit, purplish tinged in places on stems, intermediate-early in season, of moderate bearing period, lightly productive. Leaf large-medium in size, medium green in color, often purplish tinged. Flowers pink. Snap pods variable in size, very long, very curved, decidedly scimiter shaped, much curved at extreme blossom end, almost double barreled through cross section, deeply creasebacked, medium green, of coarse and undulating surface, very brittle, of inappreciable string, without fiber, of good quality. Fairly free from anthracnose. Point of pod long and curved. Green shell pods generally tinged with purple and splashed with purplish red, much depressed on outside between seeds, of much wrinkled surface, about 9⅛ inches long, and usually containing 8 or 9 seeds fairly separated in pod. Dry pods easy to thrash. Dry seeds large, extremely slender, flattish oval through cross section, invariably well rounded at ends, straight or slightly incurved at eye, very irregular in shape, generally more or less flattened, depressed, or bulged out in places, slate gray in color marked throughout with long curved stripes of black olive green, also minute area of same color around eye.

Comparison.—Little known and cultivated. The largest, straightest, and most handsome-podded of all cultivated beans, but compared to Kentucky Wonder its pods are too late and decidedly too few in number for practical usefulness, and the variety is really useful only as an exhibition or show bean. Pods, leaves, and stems same color as Scotia, but quite different in other respects. Most like Kentucky Wonder, differing principally in purplish tinged pods, leaves, and stems, and larger, straighter, later, and more double-barreled pods.

Synonym.—Holmes's Improved Sickle Pole.

History.—Introduced in 1901 by D. Landreth Seed Company.

Illustrations.—Dry seeds are illustrated on Plate III, 13; green shell pods and cross sections of same are similar to Kentucky Wonder (Pl. XV, 2, and Pl. V, 25, respectively).

VIRGINIA CORNFIELD POLE.

Listed by one seedsman. Seeds tested: Wood, 1905, 1906.

Description.—Vine of very large growth, of good climbing habit, much branched, very thick stemmed, wholly green, very late, very long in bearing, very heavily productive. Leaf medium in size, dark green in color. Flowers white. Snap pods uniform in size, long, much curved, very flat, medium green in color, of somewhat coarse surface, very tough, very stringy, of much fiber, of poor quality, very free from anthracnose. Point of pod medium in size and moderately curved. Green shell pods generally solid green, sometimes sparingly splashed wih faint purple, moderately depressed on outside between seeds, about 6¾ inches long, and usually containing 8 or 9 seeds somewhat separated in pod. Dry pods easy to thrash. Dry seeds of medium size, proportionally short, oval through cross section, truncate or rounded at ends, straight at eye, solid white.

Comparison.—Little known, little cultivated, and of very limited usefulness. Decidedly too late for planting at the North, much too tough and stringy for good

snaps, and too small-seeded and slender-podded to be recommended as a good green shell bean. Its value, if any, seems to be for planting among corn for dry beans in the South, for which purpose it is better than the present type of Southern Prolific or Missouri Wonder, as its seeds are pure white in color. Next to Powell's Prolific it is the latest in season and makes the largest growth of any variety listed by American seedsmen. More like the long flat-podded type of Southern Prolific than any other variety. Similar in general character and usefulness to Missouri Wonder and Royal Corn.

History.—Introduced in 1905 by T. W. Wood & Sons.

Illustrations.—Dry seeds resemble Royal Corn (Pl. IV, 8), differing principally in larger size; green shell pods resemble the long flat-podded type of Southern Prolific (Pl. XVI, 1), differing principally in being wider and flatter.

WHITE CREASEBACK POLE.

Listed by 82 seedsmen. Seeds tested: Armsby, 1906; Burpee, 1897, 1901, 1905; Ferry, 1900, 1902; Fish, 1905; Lompoc, 1906; May, 1905, 1906; Morse, 1906; Rice, 1905, 1906; Rogers, 1904; Routzahn, 1905; Steckler, 1905.

Description of early or true type.—Vine small in growth, at first often bushlike in habit but climbing well when once started, few branched, slender stemmed, green throughout, very early, short in bearing period, moderately to lightly productive. Leaf of medium size, of medium green color. Snap pods very uniform in size, long-medium, fairly straight, of exceedingly smooth surface, round, often double barreled or greater in diameter from side to side than from suture to suture, generally deeply creaseBacked but sometimes flat at back and front at green shell stage, medium green in color, extremely brittle, stringy, of small fiber, of very good quality, quite free from anthracnose. Point of pod short and curved. Green shell pods generally solid green, sometimes sparingly splashed with faint purple, full on outside between seeds, about 5 inches long, and usually containing 7 seeds crowded in pod. Dry pods easy to thrash. Dry seeds small, of medium length, roundish through cross section, generally more or less truncate at ends, straight at eye, solid white.

Description of late type.—Same as above except vine very large in growth, much branched, thick stemmed, very late, long in bearing, heavily productive, and pods long.

Comparison of early and late types.—One of the five most generally cultivated Kidney pole beans and largely planted in all parts of the country, especially the South. Present day stocks are much mixed and confused and usually consist either of an early or late type, or a mixture of both. The early type, which is the original true variety, is the earliest of the pole sorts to produce snap pods, and ranks equally with Kentucky Wonder and Burger's Stringless as the best extremely early snap bean for home or market. It should be similar in growth of vine and a few days earlier in season than Kentucky Wonder. Its pods should be a little smaller and of about the same shape as Powell's Prolific, and similar also to those of Scotia Pole and Byer's Bush. The pods of the late type are usually similar to the true strain, and generally differ only in slightly larger size. In some very degenerated stocks, however, the pods are very flat, but whatever the shape of pods, the season is always very late and the vines very large and coarse, so much so that in mixtures of the two types the frail slender plants of the early type are generally crowded out and rendered useless. The late type is similar in season, vine, and pod to Powell's Prolific, differing principally in the wholly green color of its pods and vines, its pure white seed, and not quite so late season. Gardeners who seek earliness will find the late type to be a great disappointment and perhaps a great loss. For these reasons seedsmen should see that they not only have the right type but that their stocks are free from late plants.

Synonyms of early or true type.—Best of All Pole, Blue Lake Creaseback Pole, Fat Horse Pole, July Pole, Missouri White Cornfield Pole, Point Market Prolific Pole, Southern Creaseback Pole, Tall July Runner Pole, White Cornfield Pole.

Synonyms of late type.—None.

History.—Apparently first listed in this country in 1881 by the former Richard Frotcher Seed Company, the predecessors of J. Steckler Seed Company. It is said to have been grown in the South many years before this time, but never brought prominently before the public until 1881.

Illustrations.—Dry seeds are illustrated on Plate IV, 7; snap pods on Plate XIX, 1; cross sections of snap pods are similar to Scotia (Pl. V, 15), differing principally in smaller size.

WHITE SICKLE POLE.

Listed by 8 seedsmen. Seeds tested: Ferry, 1900, 1904, 1905.

Description.—Vine of very large growth, of fair climbing habit, much branched, thick stemmed, wholly green, very late, long in bearing, moderately to heavily productive. Leaf of medium size, of medium green color. Flowers white. Snap pods somewhat variable in size, extremely long, very slender, very curved, especially at tip end, often much twisted, generally round, sometimes almost double barreled through cross section, deeply creasebacked both at dorsal and ventral sutures, of rough and undulating surface, medium green, very brittle, very stringy, of moderate fiber, of good quality. Point of pod long and moderately curved. Green shell pods never colored or splashed, much depressed on outside between seeds, of very wrinkled and uneven surface, about 9¼ inches long, and usually containing 8 or 9 seeds somewhat separated in pod. Dry pods easy to thrash. Dry seeds large, very slender, roundish or roundish oval through cross section, well rounded or decidedly tapering at ends, straight and slightly incurved at eye, exceedingly irregular in shape, generally bent or bulged out considerably on one side, solid white except minute area of yellow around eye.

Comparison.—One of the little known and lesser cultivated varieties. Decidedly too late for general cultivation at the North but a good late variety for snaps at the South. It is questionable, however, whether it is as desirable even in that section as Scotia, Black Kentucky Wonder, or Royal Corn. As the last-named variety is white-seeded it would seem to fill every requirement of White Sickle, with the additional advantage of being earlier and more productive. After Royal Corn the variety most resembles Kentucky Wonder, differing principally in much larger and later vine and longer, slenderer, more deeply creasebacked, more solid green pods; also similar to Tennessee Wonder.

Confusing names.—Holmes's Improved Sickle, American Sickle, both very different varieties from White Sickle.

History.—Introduced in 1882 by the former Richard Frotscher Seed Company, the predecessors of J. Steckler Seed Company. It is said to have been grown at the South for many years before that time but never brought prominently before the public until 1882.

Illustrations.—Dry seeds are illustrated on Plate IV, 23; green shell pods and cross sections of same resemble Kentucky Wonder Pole (Pl. XV, 2, and Pl. V, 25, respectively).

WHITE'S PROLIFIC POLE.

Listed by 1 seedsman. Seeds tested: Godden, 1905.

Description.—Vine of large-medium growth, of good climbing habit, moderately branched, thick stemmed, wholly green, intermediate in season, of moderate to long bearing period, heavily productive. Leaf large-medium in size, medium green in color. Flowers white. Snap pods uniform in size, very long, decidedly scimiter

curved, flat, deeply creasebacked, medium green in color, of coarse surface, brittle, stringy, of small fiber, of good quality, fairly free from anthracnose. Point of pod long and curved. Green shell pods generally sparingly splashed with faint purple, somewhat depressed on outside between seeds, about 7 inches long, and usually containing 7 or 8 seeds fairly close in pod. Dry pods easy to thrash. Dry seeds large, long, flattish oval through cross section, rounded or truncate at ends, generally straight at eye, somewhat irregular in shape, often bent or bulged out on one side, putty colored with golden bronze green stripes and also minute area of yellow ocher around eye.

Comparison.—Little known and cultivated. Excellent as snaps and green shell beans for home or market. The best variety for late snaps in places where Black Kentucky Wonder and extremely late varieties do not mature full crops. Ranks almost equally with Lazy Wife and Arlington Red Cranberry as a general-purpose snap and green shell bean. After Black Kentucky Wonder the pods most resemble Burger's Stringless, Kentucky Wonder, and Tennessee Wonder. Very similar to the English variety known as Sutton's Epicure.

Synonyms.—Noxall Pole. Rhode Island Butter Pole.

History.—Of uncertain origin and name. Some writers mention a variety of this name as early as 1850; others give it a later origin, claiming the type first originated with Fulton S. White, of Birmingham, Ala., or else in the West; while still others claim it to be renamed from Rhode Island Butter Pole. Name has been in use among American seedsmen at least since 1878.

Illustrations.—Dry seeds are illustrated on Plate II, 20, and snap pods on Plate XVIII, 2; cross sections of snap pods resemble in shape Kentucky Wonder Wax Pole (Pl. V, 26).

WORCESTER MAMMOTH POLE.

Listed by seedsmen. Seeds tested: Rawson, 1897, 1901, 1904; Ross, 1904–1906.

Description.—Vine of large growth, of poor climbing habit when young but climbing well when once started, very thick stemmed, moderately branched, green throughout, intermediate-late in season, long in bearing, moderately productive. Leaf very large, very dark green. Flowers pink. Snap pods varying in size, long, fairly straight, extremely large through cross section, flat, becoming almost round at green shell stage, of coarse surface, brittle, stringless, of inappreciable fiber, of good quality, fairly free from anthracnose. Point of pod very long, slender, and inclined to curl and twist. Green shell pods abundantly but not distinctly splashed with red, much depressed on outside between seeds, about 7 inches long, and usually containing 5 to 7 seeds very crowded in pod. Dry pods somewhat hard to thrash. Dry seeds very large, very much thickened, roundish oval through cross section, truncate or rounded at ends, rounded or full at eye, pale buff in color, freely splashed with purplish red.

Comparison.—One of the lesser grown varieties of the country. Succeeds best and is more largely planted in New England than in any other section. Although the largest seeded, thickest podded, and the most showy of the Horticultural class, it has always been an uncertain cropper in our trials and not so reliable as London Horticultural, or Childs's Horticultural, but where it grows to full perfection it is probably the best of the Horticultural varieties. Rarely as productive as Lazy Wife, Red Cranberry, Scotia, or Black Kentucky Wonder. More like Golden Carmine-Podded Horticultural than any other variety. Great differences exist in stocks, some of the poorer strains being almost as small podded and small seeded as London Horticultural or only one-half the size of the true type described above.

Synonyms.—Hampton Pole, King Horticultural Pole, Mammoth Horticultural Pole, Mugwump Pole, Shakers Pole.

History.—Introduced in 1895 by W. W. Rawson & Co., who write the variety originated with a market gardener near Worcester, Mass.

Illustrations.—Dry seeds are illustrated on Plate I, 9, and green shell pods on Plate XIX, 3.

POLE WAX-PODDED.

This comparatively small and unimportant class consists of varieties more useful for their snap pods than for their dry seed. The range in color, shape, and size of pods is not very wide, but the class contains many of the most handsome pods of any of the Kidney varieties.

ANDALUSIA WAX POLE.

Listed by 20 seedsmen. Seeds tested: Buckbee, 1900; Johnson & Stokes, 1902, 1904, 1905; Thorburn, 1897.

Description.—Vine of large growth, of poor climbing habit when young but doing well when once started, much branched, thick stemmed, somewhat yellowish green at stems, late, heavily productive, long in bearing. Leaf medium in size, medium green in color. Flowers white. Snap pods very uniform in size, of medium length, very curved, flat when young but becoming round at green shell stage, solid rich yellow, very smooth, brittle, stringless, without fiber, of good quality, fairly free from anthracnose. Point of pod short and fairly straight. Green shell pods never colored nor splashed, full on outside between seeds, about 5 inches long and usually containing 6 or 7 seeds very crowded in pod. Dry pods somewhat hard to thrash. Dry seeds of medium size, almost as broad as long, roundish oval through cross section, generally well rounded at ends, decidedly larger at one end than at other, much rounded or full at eye, solid white.

Comparison.—Little known and planted. Next to Indian Chief and Mont d'Or the best late wax bean for home or market, and being white seeded it is in some cases preferable even to these varieties. Pods very similar to Indian Chief, differing principally in being earlier, shorter, rounder, more curved, deeper yellow, and never colored or splashed.

Synonyms.—Golden Andalusia Wax Pole, Golden Lazy Wife Wax Pole.

History.—Introduced in 1890 by Johnson & Stokes, and said to have originated with a bean grower in Andalusia, Pa.

Illustrations.—Dry seeds are hardly distinguishable from Lazy Wife Pole (Pl. IV, 16); cross sections of snap pods are similar to Currie's Rustproof Wax Bush (Pl. V, 10), and green shell pods similar in shape to Red Cranberry Pole (Pl. XVIII, 3), differing principally in being exceedingly curved, thicker in cross section, and of longer pod point.

GOLDEN CARMINE-PODDED HORTICULTURAL WAX POLE.

Listed by 51 seedsmen. Seeds tested: Rogers, 1903–1906.

Description.—Vine of moderate growth, of good climbing habit, moderately branched, somewhat thick stemmed, green in color except generally inclined to yellowish green at stems, early, of moderate bearing period, heavily to moderately productive. Leaf large-medium in size, medium green in color. Flowers light pink. Snap pods somewhat varying in size, very long, generally straight, sometimes zigzag from side to side, sometimes much bent, always very flat, light yellow or yellowish green, of smooth surface, sometimes splashed with red, very brittle, stringless, without fiber, of good quality, free from anthracnose. Point of pod extremely long, very slender, generally twisted and curled. Green shell pods largely light yellow, distinctly and irregularly

splashed with bright red, sometimes a large part of pod without splashing, much sunken on outside between seeds, about 7¼ inches long, and usually containing 6 or 7 seeds fairly separated in pod. Dry pods fairly easy to thrash. Dry seeds large, a little longer than wide, rounded oval through cross section, generally well rounded at ends, rounded or full at eye, pale buff in color, generally splashed with purplish red, but sometimes with dark purple.

Comparison.—New and as yet not generally cultivated but rapidly gaining in popularity. The best and most handsome all-round pole sort for snaps, green shell, and dry shell beans for home or market. When well grown the pods are the most brilliantly splashed of all pole varieties, but they have the undesirable feature of being much undersized, bent, and twisted when not well grown and of being hardly colored at all when the weather is cloudy or the season very wet. Pods quite different from other pole varieties, but perhaps as much like Worcester Mammoth as any, differing principally in more open habit, greater earliness, and larger pods of different color.

Synonym.—Gold and Carmine Pole.

History.—Introduced by seedsmen in 1904 and originated by Rogers Brothers, of Chaumont, N. Y.

Illustrations.—Dry seeds are shown on Plate I, 11; cross sections of snap pods are similar to Golden Cluster Wax Pole (Pl. V, 27), and snap pods similar in shape to Kentucky Wonder Wax Pole (Pl. XVI, 3), differing principally in considerably wider pods and much longer pod point; green shell pods are splashed as brilliantly as those of Extra Early Horticultural Pole (Pl. XV, 1).

GOLDEN CHAMPION WAX POLE.

Listed by 9 seedsmen. Seeds tested: Ferry, 1902; Henderson, 1897, 1905.

Description.—Vine of small growth, of poor climbing habit, moderately branched, slender stemmed for a pole bean, very yellowish at stems, very early, lightly to moderately productive, of short bearing period. Leaf very light yellow, medium in size. Flowers pink. Snap pods uniform in size, long, very much curved, round, very whitish yellow, of somewhat smooth surface, somewhat tough, stringy, of moderate fiber, of fair quality, fairly free from anthracnose. Point of pod very long, very curved. Green shell pods never colored or splashed, full on outside between seeds, about 6¾ inches long, and usually containing 7 seeds very crowded in pod. Dry pods easy to thrash. Dry seeds large-medium, slender, flattish oval through cross section, rounded or truncate at ends, generally decidedly incurved at eye, mostly solid blackish blue in color, tinged sometimes with maroon or brown shades.

Comparison.—Formerly quite popular but now little planted. Decidedly lacking in productiveness, hardiness, and sure cropping qualities and apparently of no special value except possibly for earliness, though even in this respect Kentucky Wonder Wax is almost equal to it, besides immensely more productive, hardier, and a surer cropper. Being somewhat tough and stringy, it can not be recommended as a first-class snap bean for home use. Most like Andalusia Wax, differing principally in smaller, earlier vine, and longer, rounder, better filled, more whitish yellow pods, which are almost identical with those of Bismarck Black Wax Bush.

History.—Introduced in 1890 by Peter Henderson & Co., and described by them as of European origin.

Illustrations.—Dry seeds are illustrated on Plate II, 28; snap pods on Plate XVI, 5; cross section of snap pod resembles in shape that of the round-podded type of Refugee (Pl. V, 12).

GOLDEN CLUSTER WAX POLE.

Listed by 109 seedsmen. Seeds tested: Burpee, 1901; Ferry, 1902, 1903; Fish, 1903, 1904, 1906; McClure, 1903; Rice, 1905, 1906; Thorburn, 1903, 1905.

Description.—Vine of large growth, of good climbing habit, moderately branched, thick stemmed, yellowish green at stems, early-intermediate in season, productive, of long to moderate bearing period. Leaf large, light green. Flowers white. Snap pods somewhat varying in size, very long, fairly straight, very flat, of very smooth surface, clear solid whitish yellow, very brittle, stringy, of inappreciable fiber, of good quality, fairly free from anthracnose. Point of pod long and slightly curved. Green shell pods never colored or splashed except for black lines along dorsal and ventral sutures, much depressed on outside between seeds, about 7½ inches long, and usually containing 8 seeds fairly separated in pod. Dry pods easy to thrash. Dry seeds large-medium, proportionally short, flattish through cross section, truncate or rounded at ends, generally straight at eye, generally regular in shape, sometimes bent or bulging out in places, solid white.

Comparison.—A well-known standard wax variety. More extensively grown than any of the wax pole sorts but not nearly so largely cultivated as the standard green-podded pole varieties. When stocks are pure, it is, next to Golden Carmine-Podded Horticultural, the best of the wax pole sorts as snaps and green shell beans for home or market use. Most stocks of present day are, however, badly mixed and deteriorated, and for this reason it is not safe to recommend the variety unless the quality of the stock is known. The impure stocks produce many half-greenish, unattractive, undersized pods, some being almost round in shape, while the pure type makes a fine exhibition or show variety, its immense, beautiful, yellow pods attracting even more attention than those of Kentucky Wonder Wax, Sunshine Wax, or Landreth's Pole. More like Sunshine Wax than any other pole variety, the pods being hardly distinguishable from that sort except for their greater length, width, thickness, and solid yellow color which is almost without any reddish tinge whatever. Similar also to Kentucky Wonder Wax and Landreth's Pole.

Synonym.—Early Golden Cluster Wax Pole.

History.—Introduced in 1886 by Henry A. Dreer as Dreer's Early Golden Cluster Wax Pole and described as coming from stock of John Kramer, of Doylestown, Pa., who is said to have obtained the seed from Germany.

Illustrations.—Dry seeds are illustrated on Plate IV, 18; cross section of snap pod on Plate V, 27; snap pods are similar to Kentucky Wonder Wax Pole (Pl. XVI, 3), differing principally in flatter shape.

INDIAN CHIEF WAX POLE.

Listed by 26 seedsmen. Seeds tested: Farquhar, 1905; Fish, 1905.

Description.—Vine of large growth, of poor climbing habit when young, but doing well when once started, much branched, thick stemmed, generally more or less reddish tinged at stems, late, heavily productive, of long bearing period. Leaf of medium size, of medium green color. Flowers pink. Snap pods very uniform in size, medium in length, much curved, flat, becoming round at green shell stage, of a rich, solid yellow color, of very smooth surface, brittle, stringless, without fiber, of good quality, fairly free from anthracnose. Point of pod short and fairly straight. Green shell pods somewhat reddish tinged, generally faintly purplish splashed when very old, full on outside between beans, about 5⅛ inches long, and usually containing 7 or 8 seeds very crowded in pod. Dry pods fairly easy to thrash. Dry seeds of medium size, somewhat longer than wide, roundish oval through cross section, rounded or truncate at ends, rounded or full at eye, solid deep bluish black in color.

Comparison.—A well-known wax sort but not much planted at present time. Next to Mont d'Or Wax it is the best late wax pole variety and excellent as snaps for either home or market. Probably too late in season to be generally popular and evidently largely succeeded by the earlier, larger, more handsome pods of Golden Cluster Wax,

Kentucky Wonder Wax, and Golden Carmine-Podded Horticultural. In our trials it has proved to be of a different type from the samples tested of Black Wax Pole, although the two are classed by most seedsmen as identical. More like Andalusia Wax than any other, differing principally in being earlier, larger, more handsome, and more productive.

Synonyms.—Algerian Wax Pole, Black Algerian Wax Pole, Black Wax Pole, German Black Wax Pole, Tall German Black Wax Pole.

History.—Introduced into United States about 1852. Apparently the first cultivated wax-podded variety, either pole or bush.

Illustrations.—Dry seeds are illustrated on Plate II, 14; cross sections of snap pods are similar to Currie's Rustproof Wax (Pl. V, 10), and snap pods to Bismarck Black Wax Bush (Pl. VII, 1), differing principally in much flatter shape and larger size.

KENTUCKY WONDER WAX POLE.

Listed by 10 seedsmen. Seeds tested: Gregory, 1904; Johnson & Musser, 1905; Mangelsdorf, 1904–1906.

Description.—Vine of small medium growth, of good climbing habit, few branched, very open in growth, somewhat slender stemmed for a pole bean, more or less yellowish and slightly tinged with pink at stems when old, very early, of short bearing period. Leaf large-medium in size, medium green in color. Flowers white. Snap pods uniform in size, very long, fairly straight, generally turned back at stem end, flat, solid whitish yellow, of very smooth surface, very brittle, stringy, of very small fiber, of good quality, much subject to anthracnose. Point of pod medium in length and slightly curved. Green shell pods generally tinged with pink, especially at stem end and often obscurely splashed with same color, much depressed on outside between seed, about 8 inches long, and usually containing 8 seeds fairly separated in pod. Dry pods easy to thrash. Dry seeds of medium size, of medium length, flattish oval through cross section, rounded or truncate at ends, straight or slightly incurved at eye, somewhat irregular in shape, commonly bulged out or bent on one side, maroon to chocolate brown.

Comparison.—One of the lesser grown varieties, but rapidly gaining in popularity, especially at the South. Decidedly the best strictly extra early wax pole variety for home or market use. A few days later than Kentucky Wonder Pole and considerably earlier than Golden Carmine-Podded Horticultural Pole, but for a general crop bean the pure stocks of Golden Cluster Wax, Sunshine Wax, or even Golden Carmine-Podded Horticultural are more productive and longer in bearing; besides, this variety has proved in our trials to be especially subject to anthracnose, while the others mentioned were comparatively free from the disease. Most like Golden Cluster Wax, differing principally in narrower pods, smaller vines, and earlier season. Pods much larger and flatter through cross section than Kentucky Wonder, but fully as pinkish tinged at the green shell stage.

Synonyms.—Ohio Wax Pole, Prosperity Wax Pole, Salzer's Prosperity Wax Pole, Schwill's Wonderful Wax Pole.

History.—Introduced in 1901 by Johnson & Musser.

Illustrations.—Dry seeds are illustrated on Plate III, 21; cross section of snap pods on Plate V, 26, and snap pods on Plate XVI, 3.

LANDRETH'S WAX POLE.

Listed by 1 seedsman. Seeds tested: Landreth, 1905.

Description.—Vine of large growth, of good climbing habit, moderately branched, open in habit, thick stemmed, yellowish green at stems, sometimes pinkish tinged at stems when old, early, fairly productive, of moderate bearing period. Leaf large,

light green. Flowers white. Snap pods somewhat variable in size, very long, generally much curved inward, always more or less zigzag from side to side, often markedly so, extremely large, flat-oval through cross section, becoming round at green shell stage, of a clear, solid whitish yellow color, of very smooth surface, very brittle, stringy, of small fiber, of good quality, fairly free from anthracnose. Point of pod long, slightly curved. Green shell pods never colored or splashed, very much sunken on outside between seeds, about 6¾ inches long, and usually containing 7 or 8 seeds, much separated in pod. Dry pods easy to thrash. Dry seeds large-medium in size, medium in length, flattish oval through cross section, generally well rounded at ends, straight or slightly incurved at eye, irregular in shape, curved on one side and bulged out on other, maize yellow in color, marked with long circular splashes of dark hazel.

Comparison.—Little known and planted. Interesting because of exceedingly thick, zigzag-shaped pods, with deep depressions between seeds, but of no real practical value, Kentucky Wonder Wax being decidedly earlier and more handsome, and pure stocks of Golden Cluster Wax far more productive, while Golden Carmine-Podded Horticultural is a better variety in every respect. Most like Kentucky Wonder Wax in both pod and plant.

History.—Introduced in 1905 by D. Landreth Seed Company.

Illustrations.—Dry seeds are illustrated on Plate III, 11; snap pods and cross section of same are similar to Kentucky Wonder Wax (Pl. XVI, 3, and Pl. V, 26, respectively,) differing principally in exceedingly zigzag shape.

MONT D'OR WAX POLE.

Listed by 11 seedsmen. Seeds tested: Thorburn, 1901, 1902, 1905.

Description.—Vine of large growth, of poor climbing habit when young, but doing well when once started, much branched, thick stemmed, generally more or less reddish tinged at stems, intermediate-late in season, heavily productive, long in bearing. Leaf of medium size, of medium green color. Flowers pink. Snap pods very uniform in size, medium in length, straight, flat, becoming roundish oval at green shell stage, solid yellow in color, of very smooth surface, brittle, stringless, without fiber, of good quality, fairly free from anthracnose. Point of pod long and slightly curved. Green shell pods generally faintly purplish, splashed and tinged in places when old, moderately depressed on outside between seeds, about 5¼ inches long, and usually containing 8 seeds crowded in pod. Dry seeds medium in size, proportionally short, oval through cross section, rounded or truncate at ends, rounded or straight at eye, madder brown to pansy violet.

Comparison.—Little known or planted. Probably the best late wax pole variety. Earlier in season, but not quite so productive nor as vigorous a grower as Indian Chief. Excellent as snaps for home or market, but not nearly so desirable for green or dry shell beans as Golden Carmine-Podded Horticultural and most green-podded pole varieties. Most like Indian Chief, differing principally in earlier season, flatter, and straighter pods, which are very similar to those of Currie's Black Wax Bush.

History.—Listed by seedsmen in this country at least since 1885.

Illustrations.—Dry seeds are illustrated on Plate II, 15; snap pods and cross section of same are similar to Currie's Rustproof Wax Bush (Pl. VIII, 1, and Pl. V, 10, respectively).

SUNSHINE WAX POLE.

Listed by 1 seedsman. Seeds tested: Burpee, 1904, 1906.

Description.—Vine of large growth, of good climbing habit, moderately branched, thick stemmed, usually yellowish green at stems, occasionally slightly reddish tinged in places, late, heavily to moderately productive, long in bearing. Leaf large, light

green. Flowers white. Snap pods somewhat variable in size, very long, fairly straight, very flat, of a clear, solid whitish yellow color, of very smooth surface, very brittle, stringy, of small fiber, of good quality, fairly free from anthracnose. Point of pod long, slightly curved. Green shell pods often slightly reddish tinged, without black lines along sutures, much sunken on outside between seeds, about 7½ inches long, and usually containing 8 seeds fairly separated in pod. Dry pods easy to thrash. Dry seeds of medium size, proportionally short, flattish oval through cross section, truncate or rounded at ends, straight at eye, solid purplish brown.

Comparison.—Little known and planted. Same general value and usefulness as Golden Cluster Wax, and more like it than any other; but being smaller podded, later, and dark instead of white seeded it is not nearly as valuable as the pure stock of that variety. Very similar also to Kentucky Wonder Wax, differing principally in season, larger growth, and wider, flatter pods.

History.—Introduced in 1890 by W. Atlee Burpee & Co., who write that the seed was obtained on Long Island about 1887.

Illustrations.—Dry seeds are illustrated on Plate I, 22; cross section of snap pods are same as Golden Cluster Wax (Pl. V, 27); snap pods are very similar to Kentucky Wonder Wax (Pl. XVI, 3), differing principally in being wider and flatter.

CATALOGUE OF VARIETY NAMES.

The following list includes nearly all the garden beans catalogued to-day in America, the only omissions being a few kinds listed by little-known seedsmen, certain varieties of only local name, and some field sorts known only to the produce trade. The list embraces both distinct and subsidiary varieties, the former, as already explained, being represented by names signifying distinct types and the latter by names signifying other so-called varieties, or sorts, which upon trial have been found to be strains or duplicates of the distinct types, or, at least, so closely resembling them as to be practically identical.

The variety names of this list indicate in every case whether the sorts are pole, Lima, wax, or field beans, the word pole being included on all pole sorts, Lima on Lima sorts, wax on all wax sorts, and field on all field sorts. After each name is given the number of seedsmen who listed the variety in 1906. In case a name is so similar to some other as to leave no doubt that it refers to that name, then the seedsmen using such a name have been counted with those listing the preferred name; for instance, all seedsmen listing Extra Early Red Valentine, Early Red Valentine, and Cleveland's Red Valentine have been counted with those listing Red Valentine instead of each being listed separately. The seedsmen mentioned after these data are those from whom seed was obtained and upon whose samples the descriptions are largely based.

Adams's Everbearing Cluster Butter Pole Lima. (Listed by 1 seedsman. Seeds tested: Steckler, 1905, 1906.) Same as Small White Pole Lima. Apparently first listed in 1902 by J. Steckler Seed Company.

Admiral Togo. (Listed by 1 seedsman. Seeds tested: Isbell, 1906.) Same as Currie's Black Wax. First named and introduced in 1906 by S. M. Isbell & Co.

Algerian Wax Pole. (Listed by 1 seedsman.) A name applied by Alfred Bridgeman to Indian Chief Wax Pole.

Allan's Imperial Wax. (See p. 91.)

American Sickle Pole. (Listed by 1 seedsman. Seeds tested: Philips, 1905.) Same as Kentucky Wonder Pole and very different from White Sickle Pole of other seedsmen. First listed in 1891 by J. M. Philips's Sons as Philips's American Sickle Pole.

Andalusia Wax Pole. (See p. 128.)

Archias's Improved Kentucky Wonder Pole. (Listed by 1 seedsman.) Same as Kentucky Wonder Pole.

Arlington Red Cranberry Pole. (See p. 113.)

Aroostook Bush Lima. (See p. 39.)

Asparagus Pole. (Listed by 9 seedsmen.) A name sometimes applied to Yard Long Pole.

Banner Leafless Field Bean. (Listed by 1 seedsman. Seeds tested: Isbell, 1905.) Same as Navy Pea. Apparently first listed in seedsmen's catalogues by the former firm of Harry N. Hammond Seed Company, but name probably in use among farmers several years before this date.

Barteldes's Bush Lima. (See p. 40.)

Bayo Field Bean. (Not listed in seed catalogues. Seeds tested: Braslan, 1905, 1906.) This is a very large, late, semirunning field variety, extensively planted in the Sacramento Valley region of California, but possibly too late in season for growing in the East. Enormous crops are obtained in California, the yields far surpassing those obtained from field varieties grown in New York and Michigan. Wickson states there are two types, one of which is small-seeded, and known as Bayo Grande and the other large-seeded and known as Bayo Chico. The seed is said to have been brought to California from Chile about 1849. Seed of the variety is shown on Plate II, 10.

Bell's Giant Stringless Green Pod. (Listed by 1 seedsman. Seeds tested: Bell, 1906.) Same as Giant Stringless Green Pod. First listed by J. J. Bell in 1906.

Bell's Prolific Green Pod. (Listed by 1 seedsman. Seeds tested: Bell, 1905.) Same as Burpee's Stringless Green Pod. First listed in 1903 by J. J. Bell.

Best of All Bush. (See p. 54.)

Best of All Early Market Bush. (Listed by 3 seedsmen. Seeds tested: J. Bolgiano, 1905; Moore & Simon, 1905.) Same as Extra Early Refugee. First listed in 1895 by Moore & Simon.

Best of All Pole. (Listed by 5 seedsmen.) A name sometimes applied to White Creaseback Pole.

Big Sioux Pole. (Listed by 1 seedsman.) A name sometimes applied to Concord Pole.

Bismarck Black Wax. (See p. 91.)

Bismarck Great German Soup Field Bean. (Listed by 1 seedsman. Seeds tested: Moore & Simon, 1905.) Same as Navy Pea. First listed in 1905 by Moore & Simon.

Black Algerian Wax Pole. (No longer listed by American seedsmen.) A name formerly applied to the variety more recently listed as Indian Chief Wax Pole.

Black-Eyed Wax. (See p. 92.)

Black Kentucky Wonder Pole. (See p. 114.)

Black Spanish Field Bean. (No longer listed by American seedsmen.) A name formerly applied to Black Turtle Soup.

Black Turtle Soup Field Bean. (See p. 55.)

Black Valentine. (See p. 55.)

Black Wax Bush. (Listed by 109 seedsmen. Seeds tested: Thorburn, 1902.) Same as German Black Wax Bush.

Black Wax Pole. (Listed by 51 seedsmen. Seeds tested: Thorburn, 1905.) Described by most seedsmen to be same as Indian Chief Pole; but in samples received here for trial the two varieties were somewhat different, the Black Wax Pole being about five days later or about same season as Andalusia Wax Pole and its pods decidedly straighter, somewhat flatter, and more depressed between beans than Indian Chief, while its seeds were deep violet or bluish black in color. Pods apparently same as Arlington Red Cranberry Pole except in color. The variety was one of the first cultivated wax beans, having been known in this country under this name or as German Black Wax at least since 1863.

Bliss's Extra Early Pole Lima. (Listed by 1 seedsman.) Same as Extra Early Jersey Lima. A name formerly in general use but now omitted from most seed lists. Introduced in 1878 by the former firm of B. K. Bliss & Son.

Blue Lake Creaseback Pole. (Listed by 3 seedsmen. Seeds tested: Cox, 1905.) Same as White Creaseback Pole. First listed in 1903 by Cox Seed Company.

Blue Pod Butter. (See p. 56.)

Blue Pod Field. Not listed by seedsmen, but known to the produce trade of the East and grown to some extent in New York State. Very different from Blue Pod Butter of W. Atlee Burpee & Co.

Bolgiano's Early May Queen. (Listed by 1 seedsman. Seeds tested: Bolgiano, 1905.) Same as Extra Early Refugee. Introduced in 1905 by J. Bolgiano & Son.

Bolgiano's Sunshine Bush Wax. (Listed by 1 seedsman. Seeds tested: Bolgiano, 1905.) Same as Golden-Eyed Wax. An apparently recent introduction of J. Bolgiano & Son.

Bolgiano's Wax. (Listed by 1 seedsman. Seeds tested: F. Bolgiano, 1905.) Same as stringless type of Refugee Wax. First listed in 1902 by F. W. Bolgiano & Co.

Boston Favorite. (See p. 57.)

Boston Navy Field Bean. (Listed by 1 seedsman.) A name sometimes applied to Navy Pea.

Boston Pea Field Bean. (Listed by 17 seedsmen. Seeds tested: Burpee, 1901; Keeney, 1906; Johnson & Stokes, 1897.) Same as Navy Pea. Apparently first listed about twenty years ago.

Boston Yellow Eye Wax-Podded. (Listed by 1 seedsman. Seeds tested: Bolgiano, 1905.) Same as Golden-Eyed Wax, but quite different from the green-podded varieties known as Yellow Eye and Improved Yellow Eye. Named in 1905 by F. H. Ebeling.

Bountiful. (See p. 57.)

Breck's Boston Snap. (Listed by 1 seedsman. Seeds tested: Breck, 1905.) Same as Bountiful. First listed in 1904 by Joseph Breck & Sons. Described as a sport from Long Yellow Six Weeks.

Breck's Dwarf Horticultural. (Listed by 1 seedsman. Seeds tested: Breck, 1906.) Same as Boston Favorite and quite different from Dwarf Horticultural of other seedsmen. Listed by Joseph Breck & Sons at least since 1887.

Breck's String and Shell. (Listed by 1 seedsman. Seeds tested: Breck, 1902, 1905.) Same as Best of All Bush and consisting mostly of the round-podded type of that variety. Introduced in 1900 by Joseph Breck & Sons.

Brittle Wax. (Listed by 6 seedsmen. Seeds tested: Burpee, 1904; Keeney, 1904, 1906.) Same as Round Pod Kidney Wax. Introduced in 1902 by W. Atlee Burpee & Co., who state the bean originated with N. B. Keeney & Son, of Leroy, N. Y.

Broad Windsor. (See p. 37.)

Brockton Pole. (See p. 114.)

Brown Six Weeks. (Listed by 2 seedsmen.) A name frequently used prior to 1870 for Mohawk and occasionally so used by seedsmen at the present time.

Brown Speckled Valentine. (Listed by 2 seedsmen.) A name occasionally applied to Refugee.

Brown Swedish Field Bean. (See p. 58.)

Buckbee's Early Wonder Bush. (Listed by 1 seedsman. Seeds tested: Buckbee, 1905.) Same as Red Valentine. First listed in 1900 by H. W. Buckbee as Buckbee's Early Wonder Bush.

Buist's Early Lightning Valentine. (Listed by 1 seedsman. Seeds tested: Buist, 1905.) Same as Red Valentine. Introduced in 1890 by Robert Buist Seed Company.

Burger's Stringless Pole. (See p. 115.)

Burlingame Medium Field Bean. (Listed by 7 seedsmen. Seeds tested: Gregory, 1905.) A field bean of similar habit to Day's Leafless Medium. Originated about 1896 in Genesee County, N. Y.

Burpee's Bush Lima. (See p. 42.)

Burpee's Kidney Wax. (See p. 92.)

Burpee's Quarter Century Bush Lima. Same as Quarter Century Bush Lima or Wonder Bush Lima.

Burpee's Stringless Green Pod. (See p. 58.)

Burpee's White Wax. (See p. 93.)

Burpee's Willow-Leaved Bush Lima. Same as Willow-Leaved Bush Lima.

Bush Multiflora. (Not included in American seed catalogues. Apparently grown only by 1 seed grower. Seeds tested: Edward Evans, 1905, 1906.) Almost identical with Barteldes's Bush Lima, differing only in being about four days earlier, of smaller growth, and is probably more satisfactory for growing in the East and North than Barteldes's Bush Lima. Named and introduced in 1904 by Edward E. Evans, of West Branch, Mich.

Butter Bush Lima. (Listed by 1 seedsman. Seeds tested: Moore & Simon, 1904.) This name is generally used in the South in referring to the whole class of Lima beans but the above seedsmen have in this instance used it as a variety name since 1903 for Henderson's Bush Lima.

Butter Pole Lima. (Listed by 10 seedsmen.) A name applied in the South to the whole class of Lima beans, but sometimes very loosely used to designate variety names of various types of Limas, including the small-seeded, large-seeded, and potato-seeded sorts.

Butter Wax. (Listed by 19 seedsmen.) A very ambiguous name, sometimes used by gardeners to designate yellow-podded or wax varieties, but also loosely applied by some seedsmen as a variety name to designate certain types or varieties of these beans.

Byer's Bush. (See p. 59.)

Cabbage Wax. (Listed by 1 seedsman.) A name applied by T. W. Wood & Sons to Crystal Wax.

California Black Wax. (Listed by 6 seedsmen. Seeds tested: Tait, 1905.) Same as Currie's Rustproof Wax. First listed in 1902 by George Tait & Sons, who state it to be a selection of Currie's Rustproof Wax.

California Branch Field Bean. (Listed by 4 seedsmen. Seeds tested: Iowa Seed Company, 1905.) Same as Navy Pea. Apparently first listed in 1883 by James J. H. Gregory & Son.

California Butter. (Listed by 1 seedsman. Seeds tested: Haines, 1905, 1906; Lee Pioneer, 1904.) Same as Barteldes's Bush Lima. Apparently a local name.

California Pea Field Bean. (Listed by 2 seedsmen.) A name sometimes applied to Navy Pea or California Branch.

California Rustproof Wax. (Listed by 6 seedsmen. Seeds tested: Moore & Simon, 1904.) Same as Currie's Rustproof Wax. First listed in 1893 by Moore & Simon.

California Tree Field Bean. (Listed by 4 seedsmen.) A name sometimes applied to Navy Pea or California Branch.

California Wonder Field Bean. (Listed by 2 seedsmen. Seeds tested: Northrup, King & Co., 1905.) Same as Navy Pea. Introduced in 1898 by Northrup, King & Co.

Canadian Wonder. (See p. 60.)

Canavalia ensiformis. This species has never been listed by American seedsmen, but according to L. H. Bailey the plant is a tropical species and quite widely cultivated. It is fully described in Bulletin No. 115 of the Cornell University Agricultural Experiment Station, where it is stated that the species has become generally distributed throughout the Southern States during the past few years and commonly known there as Jack bean and sometimes as Chickasaw Lima and Horse bean. Its seeds are similar in shape to those of Bush Multiflora or Barteldes's Bush Lima, illustrated on Plate IV, 25. The vines ripen too late to be of value in the North and the variety is apparently of limited usefulness even in the South.

Carmine-Podded Horticultural Bush. (Listed by 2 seedsmen. Seeds tested: Gregory, 1906.) Same as Ruby Horticultural Bush. First named and introduced in 1888 by James J. H. Gregory & Son.

Carolina Bush Lima. Not listed by seedsmen, but sometimes applied by gardeners to Henderson's Bush Lima.

Carolina Pole Lima. (Listed by 22 seedsmen. Seeds tested: Johnson & Stokes, 1897.) Same as Small White Pole Lima. Known by this name for over one hundred years.

Carolina Sewee Pole Lima. Not listed by American seedsmen, but sometimes applied by gardeners to Carolina Pole Lima or Small White Pole Lima.

Challenge Black Wax. (See p. 93.)

Challenger Bush Lima. Not listed by seedsmen, but sometimes applied by gardeners to Dreer's Bush Lima.

Challenger Pole Lima. (Listed by 34 seedsmen. Seeds tested: Burpee, 1897; Dreer, 1900; Ferry, 1903, 1906; Fish, 1903, 1905; Thorburn, 1901, 1903, 1905.) Same as Dreer's Pole Lima. Introduced about 1882 by J. M. Thorburn & Co. It seems to have first attracted the attention of John M. Kumerle, of Newark, N. J., who writes the seed was obtained by him from Mr. V. J. Hedden, of East Orange, in whose family it had been for many years. Introduced as an improvement in size of pod over Dreer's Pole Lima, but at the present day seedsmen's stocks of the two kinds are commonly the same, the old smaller stock of Dreer's Pole Lima having been dropped and the larger podded Challenger used in its place.

Cherry Pole. (Listed by 3 seedsmen.) A name sometimes loosely applied to London Horticultural, but very objectionable because so often mistaken as referring to White Cherry, better known as Lazy Wife Pole.

Chickasaw Lima. A field or fodder bean, unfit for table use, and never listed by American seedsmen. Same as *Canavalia ensiformis*, previously described, and not strictly a Lima.

Childs's Extra Early Pole Lima. (Listed by 1 seedsman. Seeds tested: Childs, 1905.) Same as White Dutch Runner Pole. Introduced in 1903 by John Lewis Childs, who writes the variety originated with R. H. Palmer, of Kennedy, N. Y.

Childs's Horticultural Pole. (See p. 115.)

Chilean Field Bean. (Listed by 1 seedsman.) A name applied by Frank S. Platt Company to Red Kidney and quite different from the white-seeded pea bean sometimes sold as Chilean and Chilean Pea.

Chilean Pea Field Bean. Apparently not listed by American seedsmen, but occasionally found in local markets. A late type of field pea bean, quite similar to Lady Washington.

China Red Eye. (See p. 60.)

Concord Pole. (See p. 116.)

Cornfield Pole. (Listed by 9 seedsmen.) A name sometimes applied to Corn Hill Pole or Speckled Cut Short Pole.

Corn Hill Pole. (Listed by 41 seedsmen. Seeds tested: Ferry, 1898, 1900; Thorburn, 1901.) Same as Speckled Cut Short Pole. One of the oldest sorts now listed by American seedsmen. Probably the same as Corn bean, listed by American seedsmen about 1835.

Cranberry Pole. (Listed by 21 seedsmen.) A name loosely applied by some seedsmen to Speckled Cranberry or London Horticultural Pole.

Cream Valentine. (See p. 61.)

Crimson Beauty. (See p. 61.)

Crimson Flageolet Wax. (Listed by 5 seedsmen. Seeds tested: Keeney, 1904, 1906.) Same as Scarlet Flageolet Wax. For history see Scarlet Flageolet Wax and Purple Flageolet Wax.

Crystal Wax. (See p. 94.)

Cuban Asparagus Pole. (Listed by 7 seedsmen.) Same as Yard Long Pole.

Currie's Black Wax. Often used by seedsmen to designate Currie's Rustproof Wax.

Currie's Golden Wax. A name sometimes applied to Currie's Rustproof Wax.

Currie's Rustproof Wax. (See p. 94.)

Cut Short Pole. A name sometimes applied to Speckled Cut Short Pole.

Cylinder Black Wax. (Listed by 2 seedsmen.) Same as Prolific Black Wax. Introduced in 1889 by Peter Henderson & Co. Same origin as Prolific Black Wax.

Dallas Bush Lima. Not listed by seedsmen, but known locally in parts of Texas. Reported by Texas State Experiment Station to be same as Dreer's Bush Lima.

Davis Wax. (See p. 95.)

Day's Leafless Medium Field Bean. (See p. 62.)

Detroit Wax. (See p. 96.)

Dolichos sesquipedalis. The scientific name formerly applied to Yard Long Pole. Now known to botanists as *Vigna sesquipedalis* and to gardeners as French Yard Long, Asparagus Pole, Cuban Asparagus Pole, and Long-Podded Dolichos.

Double-Barrel Wax. (See p. 96.)

Dreer's Bush Lima. (See p. 42.)

Dreer's Pole Lima. (See p. 46.)

Dreer's Wonder Bush Lima. Same as Wonder Bush Lima.

Dutch Case Knife Pole. (See p. 116.)

Dwarf Case Knife. (Listed by 1 seedsman. Seeds tested: Kendel, 1906.) Name used in this country at least since 1865 and applied at that time to Dwarf Saber, but recently readopted by A. C. Kendel, who in 1904 applied it to Emperor William.

Dwarf Cherry. (Listed by 3 seedsmen.) A name sometimes applied to Dwarf Horticultural or Ruby Horticultural Bush.

Dwarf Cranberry. (Listed by 3 seedsmen.) A name sometimes applied to Dwarf Horticultural or Ruby Horticultural Bush.

Dwarf Horticultural. (Listed by 100 seedsmen. Seeds tested: Burpee, 1903; Ferry, 1898, 1900; Keeney, 1904, 1905, 1906; Thorburn, 1901, 1902, 1906.) The original late running type of this bean as grown in this country prior to 1875 has apparently disappeared from general cultivation. The improved strain now known as Ruby Horticultural Bush, which is decidedly earlier, more bushy, and more brilliantly splashed, is now used in filling orders for this variety. Cultivated under this name at least since 1845.

Dwarf Red Cranberry. (Listed by 3 seedsmen. Seeds tested: Breck, 1905.) As received from above seedsmen, this variety was same as Low's Champion, which is probably not the same type as that known in this country about 1880 and earlier. Listed by seedsmen at least since 1820, and one of the oldest variety names.

Dwarf White Cranberry. (No longer listed by seedsmen.) A name formerly applied to White Marrow.

Earliest Green Pod. (Listed by 1 seedsman. Seeds tested: Hammond, 1904; Isbell, 1906.) Same as Best of All Bush and composed almost wholly of the flat-podded type. First listed in 1902 by Harry N. Hammond Seed Company.

Earliest Market. (See p. 62.)

Early Aroostook Field Bean. (See p. 63.)

Early Black Pole Lima. (No longer used, or at least not now listed by seedsmen.) Introduced in 1892 by W. Atlee Burpee & Co., and described as wonderfully productive, of fine quality, and as earliest of all Limas.

Early Carmine-Podded Dwarf Horticultural. (Listed by 2 seedsmen. Seeds tested: Gregory, 1897, 1905.) Same as Ruby Horticultural Bush. Introduced in 1888 by James J. H. Gregory & Son.

Early Erfurt Dwarf Prolific Broad. (Listed by 1 seedsman. Seeds tested: Iowa, 1905.) A variety of English Broad bean, first listed in 1902 by Iowa Seed Company. Said to be earlier, more productive, and more drought resisting than the variety commonly sold in this country as Broad Windsor. Our trials showed no differences in these respects, but our results are of little importance, as the plants were grown only in New York and Virginia, which sections are unsuited to this class of beans. The variety might be given a more suitable test if grown in cooler weather or in a cooler climate, such as along the Pacific coast or in the South during winter.

Early Giant Advance Pole. (See p. 117.)

Early Golden Cluster Wax Pole. (Listed by 66 seedsmen.) Same as Golden Cluster Wax Pole.

Early Long-Podded Broad Bean. (Listed by 4 seedsmen.) A variety of English Broad bean, known to botanists as *Vicia faba.*

Early May Queen. (Listed by 1 seedsman. Seeds tested: J. Bolgiano, 1905.) Same as Extra Early Refugee. Introduced in 1905 by J. Bolgiano & Son.

Early Mazagan Broad Bean. (Listed by 6 seedsmen.) A variety of English Broad or Horse bean, known to botanists as *Vicia faba.*

Early Minnesota Field Bean. (Listed by 1 seedsman. Seeds tested: Farmer, 1905.) Same as Navy Pea. Introduced in 1905 by the Farmer Seed Company, who state the variety originated with a farmer in Rice County, Minn.

Early Mohawk Six Weeks. (Listed by 5 seedsmen.) A name sometimes applied to Mohawk.

Early Wonder Bush. (Listed by 1 seedsman. Seeds tested: Buckbee, 1905.) Same as Red Valentine. First listed in 1900 by H. W. Buckbee as Buckbee's Early Wonder Bush.

Early Wonder Pole. (Listed by 1 seedsman. Seeds tested: Page, 1905.) Same as Kentucky Wonder Pole. Apparently first listed some six years ago by Page Seed Company.

Eldorado Wax. (Listed by 1 seedsman. Seeds tested: Tait, 1902, 1905.) Same as Currie's Rustproof Wax. Introduced in 1901 by George Tait & Sons, who state it to be a selection from Currie's Rustproof Wax, made with the object of eliminating rust and increasing earliness.

Elgin White Wonder Wax. (Listed by 1 seedsman. Seeds tested: Elgin, 1905.) Same as Davis Wax. A recent introduction of Elgin Seed Company.

Elliott's Bush Lima. (Listed by 1 seedsman. Seeds tested: Elliott, 1905.) Same as Burpee's Bush Lima. First listed in 1905 by Wm. Elliott & Sons.

Elliott's Improved Pole Lima. (Listed by 1 seedsman. Seeds tested: Elliott, 1905.) Same as Dreer's Pole Lima. Introduced in 1905 by Wm. Elliott & Sons.

Emerald Beauty. (Listed by 1 seedsman. Seeds tested: J. Bolgiano, 1905.) Same as Longfellow. A recent introduction of J. Bolgiano & Son.

Emerson's Pea Field Bean. (Listed by 1 seedsman. Seeds tested: Emerson, 1904.) Test too incomplete for making a positive indentification, but variety is similar to Navy Pea, Prolific Pea, and Chilean Pea, and possibly identical with one of them.

Emperor of Russia. (Listed by 1 seedsman. Seeds tested: Thorburn, 1901, 1902.) Same as Longfellow. Introduced in 1901 by J. M. Thorburn & Co., who describe it as a new French variety.

Emperor William. (See p. 63.)

English Broad Horse Bean. (Listed by 9 seedsmen.) A name sometimes applied in this country to Broad Windsor, known to botanists as *Vicia faba.*

English Lima Horse Bean. (Listed by 1 seedsman.) A name applied by Henry Field to a variety of the English Broad bean known to botanists as *Vicia faba.*

English Stringless. (Listed by 1 seedsman.) A name applied by Moore & Simon to Moore's Newington Wonder, more generally known as Giant Stringless Green Pod.

Epicure Wax. (Listed by 1 seedsman. Seeds tested: Moore & Simon, 1902, 1904.) Same as stringy type of Refugee Wax. Introduced in 1895 by Moore & Simon, who state the variety came from a farmer in the vicinity of Wilmington, Del.

Eureka Field Bean. (See p. 64.)

Everbearing. (See p. 65.)

Evergreen Pole Lima. (Listed by 1 seedsman. Seeds tested: Maule, 1906.) Trial too poor to describe type fully, but evidently a selection or a new type similar to King of Garden. Introduced in 1906 by William Henry Maule, who states the variety was selected by a gardener near Philadelphia with a view to retaining green color of dry seed, thereby giving the cooked beans the appearance of being fresh from the garden.

Excelsior Refugee. (Listed by 1 seedsman. Seeds tested: Hastings, 1905.) Same as Extra Early Refugee. A recent introduction of H. G. Hastings & Co.

Extra Early Horticultural Pole. (See p. 117.)

Extra Early Jersey Pole Lima. (See p. 47.)

Extra Early Pole Lima. (Listed by 1 seedsman. Seeds tested: Childs, 1905.) Same as White Dutch Runner Pole. Introduced in 1905 by John Lewis Childs, who states the variety originated with R. H. Palmer, Kennedy, N. Y.

Extra Early Refugee. (See p. 65.)

Fat Horse Pole. (Listed by 15 seedsmen.) A name sometimes applied to White Creaseback Pole.

Ferry's Golden Wax. Same as Golden Wax. Introduced in 1876 by D. M. Ferry & Co.

Field's First Early. (Listed by 1 seedsman. Seeds tested: Field, 1906.) Same as Tennessee Green Pod. Introduced in 1906 by Henry Field.

First in Market. (Listed by 2 seedsmen. Seeds tested: Landreth, 1906.) Probably same as Emperor William. Introduced in 1883 by D. Landreth Seed Company as Landreth's First in Market.

Flageolet Wax. (Listed by 23 seedsmen.) When first introduced into this country from Germany, about 1880, this variety was composed of light and dark colored seed, but since its introduction the two colors have been separated into a dark-colored type now known as Violet or Purple Flageolet Wax and a light-colored type now known as Scarlet or Crimson Flageolet Wax. There are many stocks which still contain both kinds of seed, and the name Flageolet Wax may signify either the dark or light colored types.

Florida Butter Pole Lima. (See p. 47.)

Ford's Mammoth Pole Lima. (See p. 48.)

French Asparagus Pole. (Listed by 2 seedsmen.) A name applied to Yard Long Pole.

French Flageolet. (See p. 66.)

French Kidney Field. (See p. 66.)

French Lead Pencil. (Listed by 1 seedsman. Seeds tested: Noll, 1906.) Same as Longfellow. Introduced in 1902 by J. F. Noll & Co.

French Market. (Listed by 1 seedsman. Seeds tested: Schindler, 1905.) Same as Longfellow. Introduced in 1903 by Joseph A. Schindler & Co.

French Mohawk. (See p. 67.)

French Stringless. (Listed by 2 seedsmen. Seeds tested: Moore & Simon, 1902, 1904.) Same as Longfellow. Introduced in 1900 by Moore & Simon, who write the variety came from France.

French Yard Long Pole. Same as Yard Long Pole.

Frost Pole Lima. (Listed by 1 seedsman.) A name applied by James J. H. Gregory & Son to Small White Pole Lima.

Fuller's Black Wax. (Listed by 2 seedsmen.) Seeds tested: Gregory, 1898.) Same as German Black Wax. First listed by American seedsmen about 1896.

Fuller's Ringleader Wax. (Listed by 1 seedsman. Seeds tested: Gregory, 1904; Johnson & Stokes, 1897, 1904, 1906.) Same as German Black Wax. Introduced in 1896 by Johnson & Stokes.

Galega. (See p. 67.)

Galega Refugee. (No longer listed by American seedsmen. Seeds tested: Thorburn, 1903, 1905.) A name formerly applied by Thorburn and Rawson to Galega.

Garden Pride. (See p. 68.)

Genter's Sulphur Field Bean. Not listed by seedsmen, but sometimes applied in certain local markets to Eureka.

Georgia Monstrous Pole. (Listed by 1 seedsman. Seeds tested: Curry-Arrington Co., 1905.) Same as Kentucky Wonder Pole. Name apparently never recognized except by above seedsmen, who have listed the variety at least since 1898.

German Black Wax Bush. (See p. 97.)

German Black Wax Pole. (Listed by 51 seedsmen.) A name applied by some seedsmen to Black Wax Pole or Indian Chief Pole.

German Prolific Black Wax. A name sometimes applied to Prolific Black Wax.

German Soup. (Listed by 1 seedsman.) Classed by John A. Salzer Company with garden beans, but really nothing more than a cowpea. First listed in 1901 by John A. Salzer Seed Company as Salzer's Great German Soup.

German White Wax. (No longer listed by American seedsmen.) Popular about 1885, and then known also as White Wax, but now largely out of cultivation. Plants small, low growing, and very bushy. Pods very stringy, short, flat, but thick, and generally greenish tinged; seeds solid white and somewhat like White Marrow in shape. The variety now known as Burpee's White Wax is quite different from this type and a decided improvement over the old White Wax in size and quality of pods.

Giant Dwarf Wax. (Listed by 2 seedsmen. Seeds tested: Steele, Briggs & Co., 1902, 1905.) Same as Scarlet Flageolet Wax. Apparently introduced by Steele, Briggs & Co., by whom it has been listed at least since 1894.

Giant Forcer. (See p. 69.)

Giant Stringless Green Pod. (See p. 69.)

Giant Valentine. (Listed by 28 seedsmen. Seeds tested: Rogers, 1906.) Same as Giant Stringless Green Pod. Introduced in 1898 by Johnson & Stokes as Giant Stringless Green Pod Valentine. The variety more resembles a giant form of Burpee's Stringless Green Pod than it does one of Valentine, and hence the more general use of the name Giant Stringless Green Pod.

Goddard. (Listed by 33 seedsmen. Seeds tested: Keeney, 1906; Rawson, 1897.) Same as Boston Favorite. Named and introduced some time after the introduction of that variety in 1885. The variety commonly sold as Improved Goddard is generally distinct from that commonly sold as Goddard and Boston Favorite.

Gold and Carmine Pole. (Listed by 1 seedsman. Seeds tested: Everitt, 1905.) Same as Golden Carmine Podded Horticultural Pole. Introduced in 1905 by J. A. Everitt Seed Company.

Golden Andalusia Wax Pole. A name sometimes applied to Andalusia Wax Pole.

Golden Beauty Wax. (See p. 97.)

Golden Carmine-Podded Horticultural Wax Pole. (See p. 128.)

Golden Champion Wax Pole. (See p. 129.)

Golden Cluster Wax Pole. (See p. 129.)

Golden Crown Wax. (See p. 98.)

Golden-Eyed Wax. (See p. 98.)

Golden Jersey Wax. (Listed by 1 seedsman. Seeds tested: Lilly, 1905.) Same as Improved Golden Wax. Introduced in 1904 by Lilly, Bogardus & Co., the predecessors of Charles H. Lilly Company. Described by introducers as an improvement on Golden Wax.

Golden Lazy Wife Wax Pole. (Listed by 1 seedsman. Seeds tested: Moore & Simon, 1904, 1905.) Same as Andalusia Wax Pole. Introduced in 1889 by the former Samuel Wilson Company.

Golden Pole Lima. (No longer listed by American seedsmen. Seeds tested: Buckbee, 1897, 1900.) Introduced in 1897 by H. W. Buckbee as Buckbee's Golden Pole Lima, but now dropped by the seed trade. The yellowish color of its dry seeds is quite different from that of other varieties. Pods similar to those of large White Pole Lima. Variety is of no real merit.

Golden Refugee. (See p. 70.)

Golden Scimiter Wax. (Listed by 1 seedsman. Seeds tested: Henderson, 1904, 1905.) Same as Pencil Pod Black Wax. Introduced in 1903 by Peter Henderson & Co., who write the variety came from Genesee County, N. Y.

Golden Wax. (See p. 99.)

Great Northern Field Bean. (Listed only by Oscar Will Seed Company, and described as a kidney-shaped, white-seeded field bean.

Great Western Field Bean. (Listed by 1 seedsman. Seeds tested: Everitt, 1905.) Same as White Marrow. Introduced in 1897 by J. A. Everitt Seed Company.

Green Gem. (No longer listed by American seedsmen.) A name formerly applied to Wonder of France.

Green Mazagan Horse Bean. (Listed only by Alfred Bridgeman.) Described as a variety of English Horse bean known to botanists as *Vicia faba.*

Green Nonpareil Horse Bean. (Listed only by Alfred Bridgeman.) Described by Bridgeman as a variety of English Horse bean, but at one time used to designate a variey of bush Kidney bean.

Green-Seeded Flageolet. (Listed by 5 seedsmen. Seeds tested: Thorburn, 1905, 1906.) Same as Wonder of France. A French variety which has been listed at various times by American seedsmen since 1880.

Green's Golden German Wax. (Listed by 1 seedsman. Seeds tested: Green, 1905.) Same as Improved Golden Wax. Introduced in 1905 by E. C. Green & Co.

Green's Large-Seeded Mastodon Pole Lima. (Listed by 1 seedsman. Seeds tested: Burpee, 1906.) Trial too incomplete to fully describe type, but variety is evidently a very fine selection of Salem Mammoth and probably deserving recognition as an entirely new and distinct sort. Appeared in our trials to be of same class as Salem Mammoth, but much larger podded, more even, and more productive than that variety. The decidedly curved pods are apparently characteristic of the type. Introduced in 1905 by W. Atlee Burpee & Co., who write the variety originated with a Mr. Green, of Woodbury, N. J.

Grenell's Improved Golden Wax. (Listed by 13 seedsmen.) Seeds tested: Grenell, 1905; Keeney, 1906.) Same as Improved Golden Wax. Introduced about eighteen years ago by several American seedsmen. Originated by W. H. Grenell, of Pierrepont Manor, N. Y.

Grenell's Rustproof Wax. (Listed by 13 seedsmen. Seeds tested: Ferry, 1902.) Same as Improved Golden Wax. Introduced about eighteen years ago by several American seedsmen. Originated by W. H. Grenell, of Pierrepont Manor, N. Y.

Grenell's Stringless Green Pod. (See p. 70.)

Griswold's Everbearing Wax. (Listed by 1 seedsman. Seeds tested: Hastings, 1905.) Same as German Black Wax, but probably a different type as introduced by American seedsmen about 1875.

Gunkler. (Listed by 1 seedsman.) A name used by German gardeners near Rochester for Vick's Prolific Pickler.

Hammond's Luscious Stringless Wax. (No longer listed by American seedsmen. Seeds tested: Hammond, 1904.) Same as Jones's Stringless Wax. Introduced in 1904 by the former firm of Harry N. Hammond Seed Company.

Hampton Pole. (Listed by 3 seedsmen.) A name sometimes applied to Worcester Mammoth Pole.

Harlington Windsor Horse Bean. (Listed by 1 seedsman.) Described by Steele, Briggs Seed Company as a variety of English Broad or Horse bean known to botanists as *Vicia faba.*

Hemisphere Pole. (Listed by 1 seedsman. Seeds tested: Plant, 1902.) Same as Concord Pole. Introduced in 1896 by Sioux City Seed Company.

Henderson's Bush Lima. (See p. 43.)

Henderson's Full Measure. (See p. 71.)

Henderson's Ideal Pole Lima. (See p. 48.)

Henderson's Improved Bush Lima. (Listed by 4 seedsmen. Seeds tested: Henderson, 1904, 1905, 1906.) Same as Wood's Prolific Bush Lima. Introduced in 1901 by Peter Henderson & Co.

Henderson's Market Wax. (See p. 100.)

Hodson Green Pod. (See p. 71.)

Hodson Wax. (See p. 100.)

Holmes's Improved Sickle Pole. (Listed by 1 seedsman. Seeds tested: Holmes, 1904, 1905.) Same as Tennessee Wonder Pole. Introduced in 1903 by Holmes Seed Company, who write the seed was obtained in Lebanon County, Pa., where it is known as Old Time Sickle Bean.

Hopkins's Everbearing Giant Wax. (Listed by 1 seedsman. Seeds tested: Hopkins, 1904.) Same as Yosemite Wax. Introduced in 1900 by Carl S. Hopkins Seed Company.

Hopkins's Red Valentine. (Listed by 14 seedsmen. Seeds tested: Allan, 1903; J. Bolgiano, 1905; Burpee, 1903; Keeney, 1906.) Considerable difference of opinion prevails as to the identity of this variety. It is sometimes claimed to be a larger, more vigorous plant, and to bear larger, not quite so fleshy pods as the regular stock of Red Valentine, but in our trials it has not always shown these differences and usually appears to be the same as Red Valentine. Introduced by Cleveland Seed Company, and said to have originated with a Mr. Hopkins, of New York.

Horse Bean. This is a name sometimes applied to the class of beans known as English Broad Beans and classed by botanists as *Vicia faba.* It is also applied in parts of the South to *Canavalia ensiformis.*

Horticultural Cranberry Pole. (Listed by 13 seedsmen.) A name sometimes applied to London Horticultural Pole.

Horticultural Lima Pole. (Identity not yet fully known.) Type has apparently gone out of cultivation. Introduced in 1893 by D. M. Ferry & Co., and said to have originated with Alexander J. Hodges, of Pepton, Vt., from a cross between Dreer's Pole Lima and Dwarf Horticultural. Such a cross, however, is declared improbable and is generally disbelieved. Its real origin is as yet undecided.

Horticultural Pole. (Listed by 85 seedsmen. Seeds tested: Thorburn, 1902.) Same as London Horticultural Pole. Said to have been introduced into the United States from England about 1825.

Horticultural Wax. (See p. 101.)

Ice Bean. (Not listed by seedsmen.) A name sometimes applied by gardeners to Crystal Wax.

Imperial White-Seeded Wax. (Listed by 1 seedsman. Seeds tested: Maule, 1902; Rogers, 1906.) Same as Jones's Stringless Wax. Applied by William Henry Maule to Jones's Stringless Wax. Should not be confounded with Allan's Imperial Wax.

Improved Black Wax. A name generally applied by seedsmen to Prolific Black Wax, but sometimes also to German Black Wax.

Improved Goddard. (See p. 72.)

Improved Golden Wax. (See p. 101.)

Improved Yellow Eye. (See p. 72.)

Indian Chief Wax Pole. (See p. 130)

Isbell's Earliest. (Listed by 1 seedsman. Seeds tested: Isbell, 1905.) Same as Best of All Bush and consisting largely of the flat-podded type. Introduced in 1904 by S. M. Isbell & Co.

Isbell's Golden Butter Wax. (Listed by 1 seedsman. Seeds tested: Isbell, 1905.) Same as Golden Wax. Introduced in 1905 by S. M. Isbell & Co.

Isbell's Perfect Pole Lima. (Listed by 1 seedsman. Seeds tested: Isbell, 1905.) Same as White Dutch Runner Pole. Introduced in 1905 by S. M. Isbell & Co.

Jack Bean. Not listed by American seedsmen. A name applied in some sections of the South to *Canavalia ensiformis* previously described.

Jackson Wonder Bush Lima. (See p. 44.)

Japanese Asparagus Pole. (Listed by 1 seedsman.) A name applied by Moore & Simon to Yard Long Pole.

Jones's Green Pod. (Listed by 1 seedsman. Seeds tested: Maule, 1906.) Our tests of this variety have not yet been complete enough to positively determine its identity, but it is evidently very similar in appearance to Garden Pride and of same usefulness and value. Introduced in 1906 by William Henry Maule and originated by A. N. Jones, of Leroy, N. Y. Described as a cross between Burpee's Stringless Green Pod and Garden Pride.

Jones's Stringless Wax. (See p. 102.)

July Pole. (Listed by 1 seedsman.) A name applied by Vaughan Seed Company, to White Creaseback Pole.

June Bush Field Bean. (Listed by 1 seedsman.) A name applied by J. Bolgiano & Son to Navy Pea.

Keeney's Refugee Wax. A name sometimes applied to the stringless type of Refugee Wax.

Keeney's Rustless Golden Wax. (See p. 102.)

Kentucky Wonder Pole. (See p. 118.)

Kentucky Wonder Wax Pole. (See p. 131.)

Kidney Wax. (Listed by 10 seedsmen.) An ambiguous name generally used with reference to Wardwell's Kidney Wax, but sometimes also to Davis Wax.

King Horticultural Pole. (Listed by 6 seedsmen. Seeds tested: Emerson, 1905; Thorburn, 1901, 1902.) Same as Worcester Mammoth Pole. Introduced in 1895 by Schlegel & Fottler.

King of Earlies. (Listed by 4 seedsmen. Seeds tested: Tait, 1904, 1905.) Same as Black Valentine. A recent introduction of several eastern seedsmen.

King of Garden Pole Lima. (See p. 48.)

King of the Wax. (Listed by 1 seedsman. Seeds tested: Moore & Simon, 1904.) Same as Scarlet Flageolet Wax. Introduced in 1899 by Moore & Simon.

King's Improved Butter Bush Lima. (Listed by 1 seedsman. Seeds tested: King, 1904.) Same as Wood's Prolific Bush Lima. A recent introduction of T. J. King & Co.

King's Improved Pole Lima. (Listed by 1 seedsman. Seeds tested: King, 1904.) Same as Wood's Improved Pole Lima. Introduced in 1901 by T. J. King & Co.

Knickerbocker. (See p. 73.)

Kumerle Bush Lima. (Listed by 10 seedsmen. Seeds tested: Ferry, 1902; Johnson & Stokes, 1902.) Same as Dreer's Bush Lima. Originated by J. W. Kumerle, of Newark, N. J. The type was first introduced in 1889 by J. M. Thorburn & Co. as Thorburn's Bush Lima, and later became known as Kumerle Bush Lima and Dreer's Bush Lima. It is now most generally known by the latter name.

Lady Washington Field Bean. (Listed by 1 seedsman. Seeds tested: Braslan, 1905, 1906.) This is a large, late, semirunning field variety similar to Prolific Tree and extensively grown in California. It appears to be later and larger in vine and of larger, flatter seed than Prolific Tree, and possibly more productive. The name seems to have been in use for a long time both in the East and California. Often sold in eastern produce markets as Navy or Pea beans. Dry seeds of the variety are shown on Plate V, 4.

Landreth's Scarlet Wax. (Listed by 1 seedsman. Seeds tested: Landreth, 1897, 1902, 1905.) Same as Scarlet Flageolet Wax. Introduced in 1887 by D. Landreth Seed Company. Originated by A. H. Ansley & Son, of Milo Center, N. Y., by selecting the scarlet-colored seed out of the variety formerly known as Flageolet Wax.

Landreth's Wax Pole. (See p. 131.)

Large White Bush Lima. (Listed by 8 seedsmen. Seeds tested: Ferry, 1902.) Same as Burpee's Bush Lima. Named in 1895 by D. M. Ferry & Co.

Large White Pole Lima. (See p. 49.)

Lazy Wife Pole. (See p. 118.)

Leafless Medium Field Bean. A name sometimes applied to Day's Leafless Medium.

Leopard Wax. (See p. 103.)

Leviathan Pole Lima. (See p. 50.)

Lewis Pole Lima. Although not listed by seedsmen, this is the variety planted so extensively in Southern California as a field Lima bean. It sometimes consists of a mixture of several garden varieties, and the type is not usually very constant or uniform.

Lightning. (See p. 73.)

Lightning Valentine. (Listed by 3 seedsmen. Seeds tested: Buist, 1905.) Same as Red Valentine. Introduced in 1890 by Robert Buist Seed Company as Buist's Early Lightning Valentine.

Lima Wax. (Listed by 3 seedsmen.) A name sometimes applied by seedsmen to Rogers's Lima Wax.

Livingston's Hardy Wax. (See p. 104.)

Livingston's Royal Corn Pole. (Listed by 1 seedsman.) Same as Royal Corn Pole.

Livingston's Yellow Pencil Pod Wax. (Listed by 1 seedsman. Seeds tested: Livingston, 1905, 1906.) Same as stringless type of Refugee Wax. Introduced in 1900 by Livingston Seed Company.

London Horticultural Pole. (See p. 119.)

Longfellow. (See p. 74.)

Long-Podded Dolichos Pole. A name sometimes applied to Yard Long Pole.

Long-Podded Pole Lima. (See p. 50.)

Long Yellow Six Weeks. (See p. 75.)

Low's Champion. (See p. 75.)

McKenzie's Matchless Green Pod. (Listed by 1 seedsman. Seeds tested: McKenzie, 1905.) Same as Burpee's Stringless Green Pod. Introduced in 1902 by A. E. McKenzie & Co.

McKinley Refugee. (Listed by 1 seedsman.) A name sometimes applied to Golden Refugee.

Madagascar Pole. (Listed by 1 seedsman. Seeds tested: Watkins, 1905.) Same as *Dolichos lablab* of botanists and Hyacinth bean of seedsmen. Neither pods nor seeds are edible, and although catalogued by above seedsman with table varieties of beans, the species is purely ornamental and usually recommended by seedsmen merely as a desirable ornamental climber.

Mammoth Bush Lima. (Listed by 1 seedsman. Seeds tested: Glass, 1906.) Same as Burpee's Bush Lima.

Mammoth Horticultural Pole. (Listed by 19 seedsmen. Seeds tested: Ferry, 1900, 1905; Fish, 1904; Lompoc, 1905; McClure, 1904.) Same as Worcester Mammoth Pole. Named a few years after the introduction of that variety in 1895.

Mammoth Red German Wax. Listed only by William Rennie Company and described by them to be same as Giant Wax, more commonly known as Scarlet Flageolet Wax.

Mammoth Stringless Green Pod. A name sometimes applied to Giant Stringless Green Pod.

Marblehead Horticultural Bush. (See p. 76.)

Marrow Pea Field Bean. (Listed by 6 seedsmen. Seeds tested: Ferry, 1902, 1905; Johnson & Stokes, 1897.) Same as Navy Pea.

Maryland White Pole. (Listed by 1 seedsman. Seeds tested: Griffith & Turner, 1902, 1905.) Same as Lazy Wife Pole. Introduced in 1896 by Griffith & Turner.

Matchless Green Pod. (Listed by 1 seedsman. Seeds tested: McKenzie, 1905.) Same as Burpee's Stringless Green Pod. Introduced in 1902 by A. E. McKenzie & Co. as McKenzie's Matchless Green Pod.

Maule's Butter Wax. (See p. 104.)

Maule's Nameless Wax of 1906. (See p. 105.)

May Queen. (Listed by 1 seedsman. Seeds tested: J. Bolgiano, 1905.) Same as Extra Early Refugee. Introduced in 1905 by J. Bolgiano & Son, who write the seed came from Virginia.

May's Champion Pole. (Listed by 1 seedsman. Seeds tested: May, 1905, 1906.) Same as Large White Pole Lima. Introduced by L. L. May & Co., by whom it has been listed for at least twelve years.

Medium Navy Field Bean. A name sometimes applied to Day's Leafless Medium.

Mexican Bush Lima. (Listed by 1 seedsman. Seeds tested: Pierce, 1905.) Same as Barteldes's Bush Lima. A recent introduction of several Colorado seedsmen.

Mexican Pinto Field Bean. (Listed by 1 seedsman. Seeds tested: Pierce, 1906.) A very late, large-growing field bean largely planted in Colorado and California, but unknown in the North, Central, or Eastern States. Probably too late for growing as far north as Michigan and New York.

Mexican Tree Field Bean. (Listed by 4 seedsmen. Seeds tested: Livingston, 1898, Thorburn, 1897.) A name sometimes applied to Prolific Tree. Apparently first listed about twenty-five years ago and known at that time as White Branching Sugar.

Michell's Giant Pole Lima. (Listed by 1 seedsman. Seeds tested: Michell, 1905, 1906.) Department trials were too incomplete for describing this type fully, but it is evidently a large-podded, large-seeded selection of the Salem Mammoth or some other similar large-seeded variety. Introduced in 1905 by Henry F. Michell, who states it to be a selection made by a New Jersey grower.

Midsummer Wax. (Listed by 1 seedsman. Seeds tested: Salzer, 1905.) Same as Scarlet Flageolet Wax. Introduced in 1896 by John A. Salzer Seed Company.

Miller's Early Golden Stringless Wax. (Listed by 1 seedsman. Seeds tested: Moore & Simon, 1904, 1905.) Same as Valentine Wax. Introduced in 1904 by Moore & Simon, who write the seed came from Jas. R. Shallcross, Middletown, Del., who obtained the seed from a Mr. Miller.

Miller's Rustproof Wax. (Listed by 1 seedsman. Seeds tested: Mills, 1905.) Same as Currie's Rustproof Wax. Introduced in 1897 by F. B. Mills.

Milliken's Wax. (Listed by 1 seedsman. Seeds tested: Kendall & Whitney, 1902, 1905.) Same as Wardwell's Kidney Wax. Introduced in 1895 by Kendall & Whitney, who state that the seed came from a Mr. Milliken.

Missouri White Cornfield Pole. (Listed by 2 seedsmen. Seeds tested: St. Louis Seed Company, 1905.) Same as White Creaseback Pole. Named in 1898 by Plant Seed Company, who had previously listed it as White Cornfield Pole.

Missouri Wonder Pole. (See p. 120.)

Mohawk. (See p. 77.)

Mohawk Wax. (Listed by 1 seedsman. Seeds tested: Landreth, 1905.) Introduced in 1903 by D. Landreth Seed Company as Landreth's Mammoth-Seeded Golden Wax Mohawk and described as a cross between Mohawk and Scarlet Flageolet Wax. Seeds same as Mohawk and pods resembling a wax-podded Long Yellow Six Weeks. Apparently distinct, but trials as yet too poor for full report.

Monarch Wax. (See p. 105.)

Monstrous-Podded Southern Prolific Pole. (Listed by 1 seedsman. Seeds tested: Landreth, 1905.) Same as Kentucky Wonder Pole. Introduced by D. Landreth Seed Company, by whom it has been listed at least since 1890.

Mont d'Or Wax Pole. (See p. 132.)

Mottled Pole Lima. (See p. 50.)

Mountain Field Bean. (Listed by 5 seedsmen.) A name sometimes applied to Navy Pea and in other sections to White Marrow.

Mugwump Pole. Not listed by American seedsmen, but sometimes applied by gardeners to Worcester Mammoth Pole.

Muzzy's Stringless Green Pod. (Listed by 1 seedsman. Seeds tested: Muzzy, 1906.) Same as Burpee's Stringless Green Pod. Introduced by Muzzy Brothers in 1902.

Navy Pea Field Bean. (See p. 77.)

Ne Plus Ultra. (See p. 78.)

Newington Wonder. (Listed by 1 seedsman. Seeds tested: Moore & Simon, 1904, 1905.) Name used in this country at least since 1855. As sold at present time the variety is same as Giant Stringless Green Pod, but the type sold under this name about 1880 was very tough, stringy, flat-podded, and very different from above-named samples.

New York Golden Wax. (Listed by 1 seedsman. Seeds tested: Page, 1905.) Same as Improved Golden Wax. A recent introduction of Page Seed Company.

Nichol's Medium Butter Pole Lima. (Listed by 1 seedsman. Seeds tested: St. Louis Seed Company, 1905.) Same as Wood's Improved Pole Lima. Introduced in 1905 by St. Louis Seed Company.

Noll's Ideal Potato Pole Lima. (Listed by 1 seedsman. Seeds tested: Noll, 1905.) Same as Dreer's Pole Lima. Introduced in 1904 by J. F. Noll & Co., who describe it as a selection of Dreer's Pole Lima.

North Star. (Listed by 1 seedsman. Seeds tested: Great Northern, 1905.) Same as Mohawk. A recent introduction of Great Northern Seed Company, who describe it as a selection from Mohawk.

Norwood Giant Stringless. (Listed by 1 seedsman. Seeds tested: J. M. McCullough, 1904.) Same as Giant Stringless Green Pod. Introduced in 1901 by J. M. McCullough's Sons.

Noxall Pole. (Listed by 1 seedsman. Seeds tested: Maule, 1902, 1904, 1905.) Same as White's Prolific Pole. Introduced in 1902 by William Henry Maule, who writes the variety originated in Iowa and was received from a customer.

October Pole. (Listed by 1 seedsman.) A name applied by Springfield Seed Company to Concord Pole and sometimes loosely applied by gardeners to various other types of beans.

Ohio Wax Pole. (Listed by 1 seedsman. Seeds tested: J. M. McCullough, 1904.) Same as Kentucky Wonder Wax Pole. Introduced in 1903 by J. M. McCullough's Sons.

Old Homestead Pole. (Listed by 84 seedsmen. Seeds tested: Burpee, 1901.) Same as Kentucky Wonder Pole. Introduced about sixteen years ago by Peter Henderson & Co., who write the seed was obtained in Westchester County, N. Y.

Oliver Field Bean. (Listed by 1 seedsman. Seeds tested: Vaughan, 1906.) Trial too incomplete to make identification positive, but variety is evidently very similar to White Kidney and possibly a very pure stock of that variety. Introduced in 1906 by Vaughan Seed Company.

One Thousand to One. (Listed by 1 seedsman.) A name often applied to Refugee.

Onondaga Pole. (Listed by 1 seedsman. Seeds tested: Ebeling, 1903.) Trials too incomplete for positive identification, but variety is evidently distinct and valuable. Introduced in 1898 by F. H. Ebeling, who describes it as belonging to the Horticultural class.

Page's Extra Early. (Listed by 1 seedsman. Seeds tested: Page, 1905.) Same as Extra Early Refugee. A recent introduction of Page Seed Company.

Painted Lady Pole. (Listed by 5 seedsmen. Seeds tested: Price, 1903.) An old European sort of the Multiflora class which has been listed by American seedsmen at least since 1855. Test too incomplete for full description, but variety evidently similar to Scarlet Runner, differing principally in being smaller podded and each flower red and white in color. Useful as an ornamental climber, but not as desirable for snaps as Scarlet Runner.

Panmure Extra Early Pole Lima. (Listed by 1 seedsman. Seeds tested: Maule, 1904–1906.) Trials too incomplete for full description, but variety is evidently a fine selection of the Extra Early Jersey or some other large-seeded sort. Valuable for combination of extreme earliness and large pods. Possibly distinct and very valuable. Introduced in 1903 by William Henry Maule and said to have originated with a California seed grower.

Pencil Pod Black Wax. (See p. 106.)

Perfection Wax. (Listed by 22 seedsmen. Seeds tested: Burpee, 1897, 1901, 1902; Keeney, 1904; McKenzie, 1905.) Same as Purple Flageolet Wax. Introduced in 1887 by W. Atlee Burpee & Co. Originated by A. H. Ansley & Son, of Milo Center, N. Y., by separating the darker colored seed from the German variety known at that time as Flageolet Wax.

Perfectly Straight Round Pod. (Listed by 1 seedsman. Seeds tested: Steckler, 1904.) Same as Longfellow. Introduced in 1903 by J. Steckler Seed Company, as Steckler's Perfectly Straight Round Pod.

Pinks Field Bean. (Listed only by Johnson & Musser. Seeds tested: Braslan, 1905 1906.) This is a large, late, semirunning field variety extensively grown in California, especially in San Luis Obispo County and in the Sacramento and San Joaquin valleys. It is of similar habit to the Bayo and Red Mexican varieties, and like them is very late in season and so far has never been listed by Eastern seedsmen nor cultivated in the bean-growing districts of New York and Michigan. The beans are very much liked by the Spanish people, by whom it seems to have been first brought into California. Dry seeds are illustrated on Plate II, 13.

Point Market Prolific Pole. (Listed by 1 seedsman. Seeds tested: J. Bolgiano, 1906.) Same as White Creaseback and consisting wholly of the true early type of that variety. Introduced in 1906 by J. Bolgiano & Son.

Potato Bush Lima. A name sometimes applied to Dreer's Bush Lima, but more often used as a class name to designate the thick-seeded bush Limas.

Potato Pole Lima. A name sometimes applied to Dreer's Pole Lima, but more often used as a class name to designate the thick-seeded pole Limas.

Powell's Prolific Pole. (See p. 120.)

Powell's Yellow Giant Wax Pole. (Listed by 1 seedsman. Seeds tested: Vick, 1905.) Introduced in 1904 by James Vick's Sons and said to have been originated by a Rev. E. P. Powell, of New York State. Trials too incomplete for making a positive identification, but variety is evidently of same type as Golden Cluster Wax, Kentucky Wonder Wax and Sunshine Wax, and possibly identical with one of these varieties.

Pride of Newton. (Listed by 1 seedsman. Seeds tested: Steckler, 1903, 1905; Thorburn, 1897, 1901, 1902.) Same as Long Yellow Six Weeks. Introduced in 1888 by J. M. Thorburn & Co.

Princess Pole. No longer listed by seedsmen. A name formerly applied to Dutch Case Knife Pole.

Prize Winner Field Bean. (Listed by 2 seedsmen. Seeds tested: Green, 1905; Wills, 1905.) Same as Navy Pea. Introduced in 1901 by the former firm of A. I. Root Seed Company.

Profusion Wax. (Listed by 1 seedsman. Seeds tested: Maule, 1903, 1904.) Same as stringless type of Refugee Wax. Introduced in 1903 by William Henry Maule.

Prolific Black Wax. (See p. 107.)

Prolific Bush Lima. A name sometimes applied to Wood's Prolific Bush Lima.

Prolific Everbearing Rustproof Wax. (Listed by 1 seedsman. Seeds tested: Moore & Simon, 1902, 1904.) Same as Davis Wax. Introduced in 1896 by Moore & Simon.

Prolific German Black Wax. (Listed by 16 seedsmen. Seeds tested: Burpee, 1901; Johnson & Stokes, 1897; Ferry, 1899, 1900, 1903.) Same as Prolific Black Wax and of the same origin and introduction.

Prolific Pickler. (Listed by 1 seedsman. Seeds tested: Vick, 1905.) Same as Vick's Prolific Pickler.

Prolific Tree Field Bean. (See p. 78.)

Prosperity Wax Pole. (Listed by 1 seedsman. Seeds tested: Salzer, 1905.) Same as Kentucky Wonder Wax Pole. Introduced in 1905 by John A. Salzer Seed Company.

Purple Flageolet Wax. (See p. 107.)

Quarter Century Bush Lima. (Listed by 9 seedsmen. Seeds tested: Burpee, 1905.) Same as Wonder Bush Lima. Introduced in 1901 by W. Atlee Burpee & Co. as Burpee's Quarter Century Bush Lima. Said to have been originated by J. B. Kelsey, Santa Paula, Cal., from a selection of the most compact early plants of Burpee's Bush Lima.

Rapp's Favorite. This name was first used in 1900 by Johnson & Musser, but has now gone out of use, the name having been changed in 1904 to French Mohawk, by which the type is at present known.

Red Cranberry Bush. (Listed by 2 seedsmen. Seeds tested: Breck, 1905.) Same as Low's Champion, but probably a different type from that sold under this name previous to 1885. A variety of this name known also as Rob Roy was listed by American seedsmen as early as 1828.

Red Cranberry Pole. (See p. 121.)

Red Flageolet Wax. (Listed by 8 seedsmen. Seeds tested: Thorburn, 1897, 1901, 1902.) Same as Scarlet Flageolet Wax.

Red German Wax. (Listed by 1 seedsman. Seeds tested: Rennie, 1905.) Composed of Scarlet Flageolet Wax and Violet Flageolet Wax. Apparently introduced by William Rennie, by whom it has been listed at least since 1894.

Red Kidney Field Bean. (See p. 79.)

Red Mexican Field Bean. (Not listed in seed catalogues. Seeds tested: Braslan, 1905, 1906.) This is a large, late, semirunning field variety grown extensively in California, Colorado, and other parts of the West. It is of similar habit to Bayo and Pinks and, like them, much more productive than eastern field varieties, but possibly too late in season to be grown in New York or Michigan. It is thought to be of Spanish or Mexican origin and seems to have been first cultivated in this country in California. Seeds of the variety are illustrated on Plate I, 21.

Red-Podded Dwarf Horticultural. (Listed by 1 seedsman. Seeds tested: Gregory, 1905.) Same as Boston Favorite. Name apparently first used about 1888 by James J. H. Gregory & Son, but should not be confounded with either Dwarf Horticultural or Ruby Horticultural Bush of present day.

Red Valentine. (See p. 79.)

Refugee. (See p. 80.)

Refugee Wax. (See p. 108.)

Rennie's Stringless Wax. (Listed by 1 seedsman. Seeds tested: Rennie, 1905.) Sample comprised Scarlet Flageolet Wax and Violet Flageolet Wax. Introduced in 1898 by William Rennie.

Rhode Island Butter Pole. (Listed by 1 seedsman. Seeds tested: Huntington & Page, 1905.) Same as White's Prolific Pole. Listed by seedsmen in this country at least since 1867. Name almost out of use and type at present is best known as White's Prolific Pole.

Rogers's Lima Wax. (See p. 109.)

Rose. (Listed by 1 seedsman.) A name applied by Henry Philipps Seed Company to Canadian Wonder, but apparently first used by James J. H. Gregory & Sons in 1880.

Round Pod Kidney Wax. (See p. 109.)

Round Yellow Six Weeks. (See p. 81.)

Royal Corn Pole. (See p. 121.)

Royal Dwarf Kidney Field Bean. (Listed by 31 seedsmen. Seeds tested: Ferry, 1900, 1905; Keeney, 1904.) Same as White Kidney. Cultivated in this country at least since 1857.

Ruby Horticultural Bush. (See p. 81.)

Rustproof Golden Wax. (Listed by 26 seedsmen. Seeds tested: Buckbee, 1902.) Same as Improved Golden Wax. Introduced about 1888.

Saba Pole. (No longer listed by seedsmen.) A name formerly applied to Small White Lima.

Saddleback Wax. (Listed by 17 seedsmen. Seeds tested: Burpee, 1902; Ferry, 1900; Keeney, 1906; Rogers, 1904.) Introduced in 1890 by W. Atlee Burpee & Co. as Burpee's Saddleback Wax and originated by N. B. Keeney & Son, of Le Roy, N. Y. Variety is very similar to and of practically the same usefulness as German Black Wax. Some seed sold under this name is apparently the same as German Black Wax. Further trials are necessary before stating its exact identity and value.

St. Louis Seed Company's Improved Bush Lima. (Listed by 1 seedsman. Seeds tested: St. Louis Seed Company, 1904.) Same as Wood's Prolific Bush Lima. Introduced in 1904 by St. Louis Seed Company.

Salem Mammoth Pole Lima. (See p. 51.)

Salzer's Bush Lima. (Listed by 1 seedsman. Seeds tested: Salzer, 1904.) Same as Dreer's Bush Lima. Named in 1903 by John A. Salzer Seed Company.

Salzer's Earliest Wax. (Listed by 1 seedsman. Seeds tested: Salzer, 1905.) Same as Allan's Imperial Wax. Introduced about 1890 by John A. Salzer Seed Company.

Salzer's Giant Stringless Wax. (Listed by 1 seedsman. Seeds tested: Salzer, 1905.) Same as Pencil Pod Black Wax. Introduced in 1901 by John A. Salzer Seed Company.

Salzer's Prosperity Wax Pole. (Listed by 1 seedsman. Seeds tested: Salzer, 1905.) Same as Kentucky Wonder Wax Pole. Introduced in 1905 by John A. Salzer Seed Company.

Salzer's Round-Podded Wax. (Listed by 1 seedsman. Seeds tested: Salzer, 1905.) Same as German Black Wax. Introduced in 1897 by John A. Salzer Seed Company.

Salzer's Tree Field Bean. (Listed by 1 seedsman. Seeds tested: Salzer, 1905.) Same as Navy Pea. Listed by John A. Salzer Seed Company at least since 1894.

Salzer's White Wonder Field Bean. (Listed by 1 seedsman. Seeds tested: Salzer, 1905.) Same as Day's Leafless Medium. Apparently named by John A. Salzer Seed Company about 1892.

Scarlet Flageolet Wax. (See p. 110.)

Scarlet Runner Pole. (See p. 40.)

Schwill's Monstrous Pole Lima. (Listed by 1 seedsman. Seeds tested: Schwill, 1905, 1906.) Same as King of Garden Pole Lima. Introduced in 1904 by Otto Schwill & Co.

Schwill's Quick Crop. (Listed by 1 seedsman. Seeds tested: Schwill, 1905.) Same as Earliest Market. Introduced in 1905 by Otto Schwill & Co.

Schwill's Royal Corn Pole. (Listed by 1 seedsman.) Apparently the same as Livingston's Royal Corn Pole, described on page 121 as Royal Corn.

Schwill's Wonderful Wax Pole. (Listed by 1 seedsman. Seeds tested: Schwill, 1905.) Same as Kentucky Wonder Wax Pole. Introduced in 1904 by Otto Schwill & Co.

Scotia Pole. (See p. 122.)

Seibert's Pole Lima. (See p. 51.)

Sewee Pole Lima. A name formerly applied to Small White Pole Lima.

Shaker's Pole. (Listed by 1 seedsman. Seeds tested: Gordinier, 1906.) Same as the smaller-seeded stock of Worcester Mammoth Pole. Introduced in 1906 by W. H. Gordinier. So named because largely cultivated by the Shakers of New York State.

Shipper's Favorite. (Listed by 1 seedsman. Seeds tested: Buist, 1902, 1905.) Same as Best of All Bush and consisting largely of the flat-podded type. Introduced by the Robert Buist Company about 1888.

Shotwell's Pole Lima. (Listed by 3 seedsmen. Seeds tested: Johnson & Stokes, 1897, 1902, 1904, 1906.) Same as Dreer's Pole Lima. Introduced in 1896 by Johnson & Stokes and originated by the late Jacob R. Shotwell, of Rahway, N. J.

Sieva Bush Lima. (Listed by 5 seedsmen. Seeds tested: Ferry, 1902.) Same as Henderson's Bush Lima. Name first came into use about 1896.

Sieva Pole Lima. (Listed by 36 seedsmen. Seeds tested: Rice, 1906.) Same as Small White Pole Lima. Name has been in common use at least since 1800.

Silver Refugee. (Listed by 1 seedsman. Seeds tested: Keeney, 1904, 1905.) Same as Golden Refugee. Name apparently in use only among canners and bean growers.

Silver Wax. (Listed by 4 seedsmen. Seeds tested: Holmes, 1905; Maule, 1902, 1905.) Same as Crystal Wax. Introduced in 1900 by Holmes Seed Company as Holmes's Improved Silver Wax.

Simmers's Early Giant Wax. (Listed by 1 seedsman. Seeds tested: Simmers, 1905.) Sample comprising Scarlet Flageolet and Violet Flageolet Wax. Described by J. A. Simmers Seed Company as having originated in Germany and introduced by their seed house in 1897.

Sion House Forcing. (Listed by 1 seedsman. Seeds tested: Michell, 1905.) Same as Best of All Bush and consisting wholly of the round-podded type. A well-known European sort listed by American seedsmen at various times since about 1880. This sample was much more even than those of Best of All Bush.

Skillman's Pole Lima. (No longer listed by seedsmen. Seeds tested: Johnson & Musser, 1905, 1906.) Apparently same as Seibert's Pole Lima. Introduced in 1905 by Johnson & Musser, but apparently never listed except by this firm and not by them after 1905. Said to have been originated in 1900 by John Skillman of Palms, Cal.

Small Carolina Pole Lima. A name sometimes applied to Small White Pole Lima.

Small Horse Bean. (Listed by 1 seedsman.) Described by Thorburn as a variety of Horse bean known to botanists as Vicia faba.

Small White Bush Lima. A name sometimes applied to Henderson's Bush Lima.

Small White Pole Lima. (See p. 52.)

Snowflake Field Bean. (See p. 82.)

Southern Creaseback Pole. (Listed by 6 seedsmen. Seeds tested: Thorburn, 1897, 1905.) Same as White Creaseback Pole. Named some time after the introduction of White Creaseback in 1881.

Southern Prolific Pole. (See p. 122.)

Southern Willow-Leaved Sewee Pole Lima. A name sometimes applied to Willow-Leaved Pole Lima.

Speckled Beauty Pole Lima. (Listed by 1 seedsman.) Apparently first catalogued in 1906 by Otto Schwill & Co. The description given by them states that the variety is the same as Calico Pole Lima, and indicates that it is similar to or identical with Florida Butter Pole Lima.

Speckled Cranberry Bush. (Listed by 2 seedsmen.) A name sometimes applied to Ruby Horticultural Bush.

Speckled Cranberry Pole. (Listed by 48 seedsmen. Seeds tested: Ferry, 1898, 1900, 1903; Fish, 1903–1905; Rawson, 1901; Thorburn, 1897.) Same as London Horticultural Pole. Name has been in common use since about 1855.

Speckled Cut Short Pole. (See p. 123.)

Speckled Wax. (See p. 111.)

Steckler's Calico Bush Lima. (Listed by 1 seedsman. Seeds tested: Steckler, 1906.) Same as Jackson Wonder Bush Lima. Introduced in 1906 by J. Steckler Seed Company.

Steckler's Perfectly Straight Round Pod. (Listed by 1 seedsman. Seeds tested: Steckler, 1904.) Same as Perfectly Straight Round Pod, more generally known as Longfellow. Introduced in 1903 by J. Steckler Seed Company.

Stokes's Evergreen Pole Lima. (Listed by 1 seedsman. Seeds tested: Johnson & Stokes, 1905, 1906.) Trial too incomplete to describe type fully, but pod evidently of same class as Salem Mammoth, and possibly a selection of that variety. Apparently a different type of pod from Evergreen Pole Lima of William Henry Maule. Introduced about 1892 by Johnson & Stokes, who state the variety to be valuable and distinct because of seeds holding their green color at all stages, even the dry seeds remaining green when cooked.

Sunshine Bush Wax. (Listed by 1 seedsman. Seeds tested: Bolgiano, 1905.) Same as Golden Eyed Wax. Apparently a recent introduction of J. Bolgiano & Son.

Sunshine Wax Pole. (See p. 132.)

Sutton's Dwarf Forcing. (Listed by 1 seedsman. Seeds tested: Moore & Simon, 1906.) Trial too poor to make a full description of the type, but evidently a very distinct sort, peculiar for very small size of plant, exceedingly compact habit, and numerous fruit spurs projecting high above foliage. Pods more like Ne Plus Ultra than any other on trial, differing principally in being darker green in color, smaller and narrower in shape of pod, and shorter in pod point. First listed in this country in 1906 by Moore & Simon, and apparently introduced from England.

Sutton's Dwarf Sugar. (Listed by 1 seedsman. Seeds tested: Schlegel & Fottler, 1905.) Same as Best of All Bush, and consisting wholly of the round-podded type. Introduced from England, and first listed in this country by Schlegel & Fottler in 1905. Much more even and purer than present stocks of Best of All.

Sutton's Perfection. (Listed by 1 seedsman. Seeds tested: Schlegel & Fottler, 1903.) Same as Longfellow. An English sort first listed in this country by Schlegel & Fottler in 1903.

Sword Long Pod Horse Bean. (Listed by 4 seedsmen.) A variety of Horse bean known to botanists as *Vicia faba*.

Tait's White Wax. (Listed by 1 seedsman. Seeds tested: J. Bolgiano, 1905.) Same as Davis Wax. Introduced about 1898 by Geo. Tait & Sons.

Tall German Black Wax Pole. A name often applied to Black Wax Pole.

Tall July Runner Pole. (Listed by 1 seedsman. Seeds tested: Thorburn, 1901, 1902, 1905.) Same as White Creaseback Pole, and composed wholly of the true, round-podded type. Introduced from Germany in 1900 by J. M. Thorburn & Co.

Tall Sioux Pole. (Listed by 2 seedsmen. Seeds tested: Field, 1904; Sioux, 1905.) Same as Concord Pole. Introduced about 1898 by Sioux City Seed Company.

Tampico Field Bean. No longer listed by American seedsmen. A name formerly applied to Black Turtle Soup.

Taylor's Green Pod. (See p. 82.)

Tennessee Green Pod Bush. (See p. 83.)

Tennessee White Corn Hill Pole. (Listed by 1 seedsman. Seeds tested: Moore & Simon, 1905.) Same as Dutch Case Knife Pole. Introduced in 1897 by Moore & Simon, who state the seeds came from Tennessee

Tennessee Wonder Pole. (See p. 124.)

Texas Prolific Pole. (Listed by 4 seedsmen. Seeds tested: Hastings, 1905.) Same as Kentucky Wonder Pole. Origin of name is obscure. Possibly known locally for many years, but apparently not recognized in seedsmen's lists until quite recently.

Thorburn's Bush Lima. (Listed by 10 seedsmen. Seeds tested: Thorburn, 1901, 1904, 1905.) Same as Dreer's Bush Lima. Introduced in 1889 by J. M. Thorburn & Co. Originated by J. W. Kumerle of Newark, N. J. Type now generally known as Dreer's Bush Lima.

Thorburn's Prolific Market. (See p. 83.)

Thorburn's Refugee Wax. (Listed by 1 seedsman. Seeds tested: Thorburn, 1901, 1902.) As now sold, this variety is same as stringless type of Refugee Wax, but is said to have been distinct when first introduced in 1890 by J. M. Thorburn & Co. Said to have been derived from Extra Early Refugee.

Tom Thumb. (No longer listed by American seedsmen. Seeds tested: Landreth, 1905.) Very similar to and possibly identical with Wonder of France. Introduced in 1903 by D. Landreth Seed Company, as Landreth's Tom Thumb, but apparently never listed except in 1903 and 1904 by above seedsmen.

Triumph of Frames. (See p. 84.)

Trucker's Delight Pole Lima. (Listed by 1 seedsman. Seeds tested: Holmes, 1902, 1904, 1906.) Very similar to and possibly same as Seibert's Pole Lima. Introduced in 1902 by Holmes Seed Company.

Tucker's Prolific Bush Lima. (Listed by 1 seedsman. Seeds tested: Texas, 1904, 1905.) Same as Wood's Prolific Bush Lima. Introduced in 1903 by several American seedsmen. Said to have originated with George Tucker, Old Church, Va.

Turtle Soup Field Bean. A name sometimes applied to Black Turtle Soup.

Union White Valentine. (No longer listed by seedsmen. Seeds tested: Johnson & Stokes, 1897.) Same as White Valentine. Name has been in use since about 1890.

Valentine Wax. (See p. 111.)

Veitch's Forcing. (See p. 84.)

Ventura Wonder Wax. (Listed by 3 seedsmen. Seeds tested: Johnson & Musser, 1905.) Same as Davis Wax. Introduced in 1900 by Johnson & Musser.

Vick's Prolific Pickler. (See p. 85.)

Vienna Forcing. (See p. 85.)

Vineless Marrow Field Bean. (See p. 86.)

Violet Flageolet Wax. (Listed by 10 seedsmen.) A name sometimes applied to Purple Flageolet Wax.

Virginia Cornfield Pole. (See p. 124.)

Walter's Prolific Pole Lima. (Listed by 1 seedsman. Seeds tested: Moore & Simon, 1904, 1906.) Same as Dreer's Pole Lima. Introduced in 1901 by Moore & Simon, who write the variety originated with Henry Walter, of Rancocas Creek, N. J.

Wardwell's Kidney Wax. (See p. 112.)

Warren Bush. (See p. 86.)

Warwick. (See p. 87.)

White Cherry Pole. (Listed by 1 seedsman. Seeds tested: Griffith & Turner, 1905.) Same as Lazy Wife Pole. Name used by above-named seedsmen at least since 1890 and probably by others long before that time.

White Cornfield Pole. (Listed by 1 seedsman. Seeds tested: Schisler-Corneli, 1905.) Same as White Creaseback Pole. Name apparently first used by above-named seedsmen.

White Cranberry Bush. Name used as early as 1830, but now out of use among seedsmen, or at least not now to be found in seed catalogues.

White Cranberry Pole. A name now sometimes applied to Lazy Wife Pole; but as used about 1830 it seems to have designated a sort smaller seeded than Lazy Wife Pole.

White Creaseback Pole. (See p. 125.)

White Dutch Runner Pole. (See p. 41.)

White Kidney Field Bean. (See p. 87.)

White Kidney Wax. (Listed by 4 seedsmen.) A very ambiguous name, but generally used with reference to Davis Wax.

White Marrow Field Bean. (See p. 88.)

White Mexican Field Bean. (Listed by 1 seedsman. Seeds tested: Hastings, 1905.) Same as Navy Pea. Name apparently first used by seedsmen about 1885.

White Sickle Pole. (See p. 126.)

White Valentine. (See p. 88.)

White Wax. (Listed by 34 seedsmen.) The old bean formerly cultivated in this country as White Wax and German White Wax was one of the first used wax-podded bush varieties, but the old type of this name has apparently gone out of use. The type now sold under this name is generally Davis Wax, which is a very different variety from the true type of thirty years ago, and quite different from Burpee's Stringless White Wax of present day.

White Wonder Bush Field Bean. (Listed by 6 seedsmen.) A name applied in the West to a variety of field bean.

White Wonder Pole. This name is sometimes used by California growers for White Sickle Pole, but has never been included in seedsmen's lists.

White's Prolific Pole. (See p. 126.)

Wilkie's Perfection Prize Pole Lima. (Listed by 1 seedsman. Seeds tested: Moore & Simon, 1904–1906.) Very similar to and possibly identical with Ford's Mammoth Pole Lima. Introduced in 1892 by Moore & Simon, who state that the variety originated with Thomas Wilkie, a Philadelphia market gardener.

Willet's Bush Lima. (Listed by 1 seedsman. Seeds tested: Willet, 1905.) Same as Burpee's Bush Lima. Introduced in 1905 by N. L. Willet Drug Company.

Willing's Pride Pole. (Listed by 1 seedsman. Seeds tested: Salzer, 1905.) Same as Southern Prolific Pole and consisting wholly of the long flat-podded type. Apparently introduced by the John A. Salzer Seed Company, by whom it has been listed since 1894.

Willow-Leaved Bush Lima. (See p. 44.)

Willow-Leaved Pole Lima. (See p. 52.)

Wisconsin Tree Field Bean. (Listed by 1 seedsman. Seeds tested: Moore & Simon, 1904, 1905.) Same as White Marrowfat. Introduced in 1893 by J. A. Everitt Seed Company.

Wonder Bush Lima. (See p. 45.)

Wonder of France. (See p. 89.)

Wood's Bacon Bean. (No longer listed by American seedsmen. Seeds tested: Wood, 1905.) A variety of English Broad or Horse beans known to botanists as Vicia faba. Introduced in 1897 by T. W. Wood & Sons.

Wood's Earliest Hardiest. (No longer listed by American seedsmen. Seeds tested: Wood, 1903.) Introduced in 1893 by T. W. Wood & Sons. Same type of bean as Earliest Market and possibly identical with it or Emperor William.

Wood's Earliest Red Valentine. (Listed by 1 seedsman. Seeds tested: Wood, 1903.) Same as Red Valentine. Introduced in 1895 by T. W. Wood & Sons.

Wood's Improved Pole Lima. (See p. 53.)

Wood's Prolific Bush Lima. (See p. 45.)

Worcester Mammoth Pole. (See p. 127.)

Wren's Egg Pole. (Listed by 16 seedsmen. Seeds tested: Burpee, 1901; May, 1897.) Same as London Horticultural Pole. Name used in this country since about 1865 to designate London Horticultural.

Yankee Winter. (See p. 89.)

Yard Long Pole. (See p. 38.)

Yellow Cranberry. (See p. 90.)

Yellow Eye Field Bean. (Listed by 3 seedsmen. Seeds tested: Haskell, 1905.) A very old field variety listed by American seedsmen at least since 1874 and formerly grown more extensively than at present. Department trials were too incomplete to afford a basis for description, but enough development was made to show that the variety is distinct and of about the same general usefulness as Improved Yellow Eye, which it resembles more than any other, differing principally in narrower, flatter seed, with smaller area of yellow around eye or of about the same color and shape of seed as Golden-Eyed Wax (Pl. III, 1); while pods are narrower and vine less spreading in habit than Improved Yellow Eye.

York Wax. (Listed by 1 seedsman.) Same as Golden Wax. One of the first cultivated wax varieties. First listed by James J. H. Gregory & Son about 1870.

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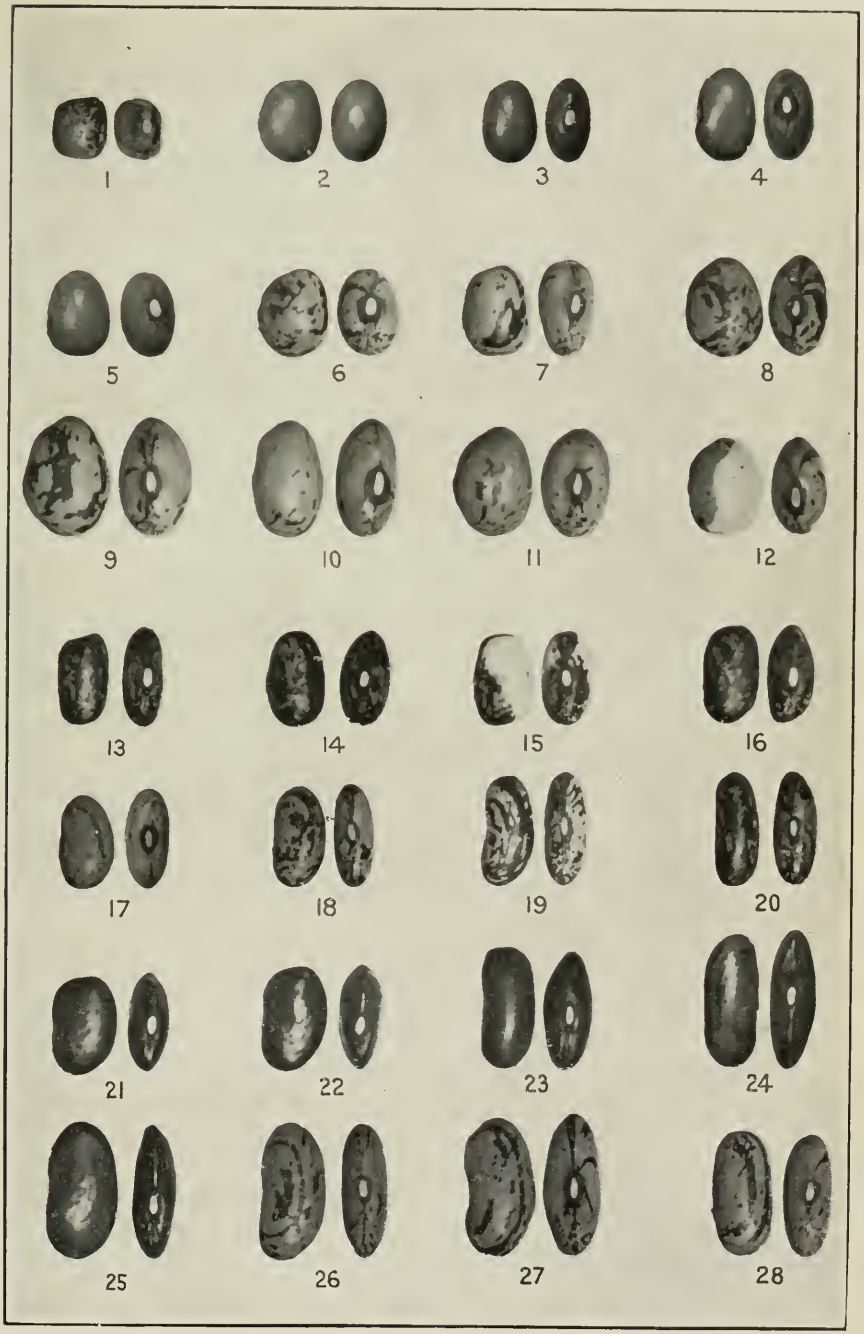
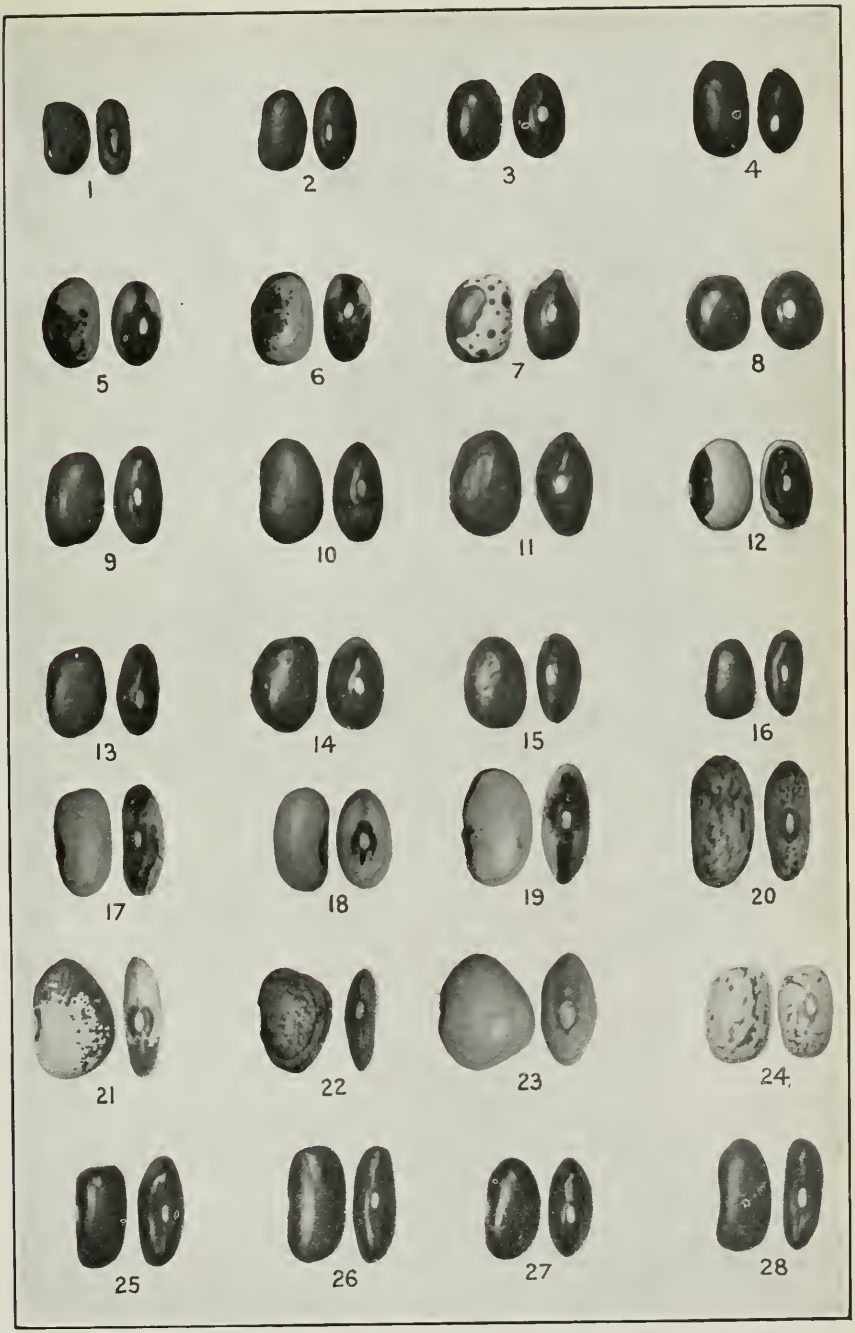


SIDE AND VENTRAL VIEWS OF RIPE SEEDS.

(Natural size.)



SIDE AND VENTRAL VIEWS OF RIPE SEEDS.

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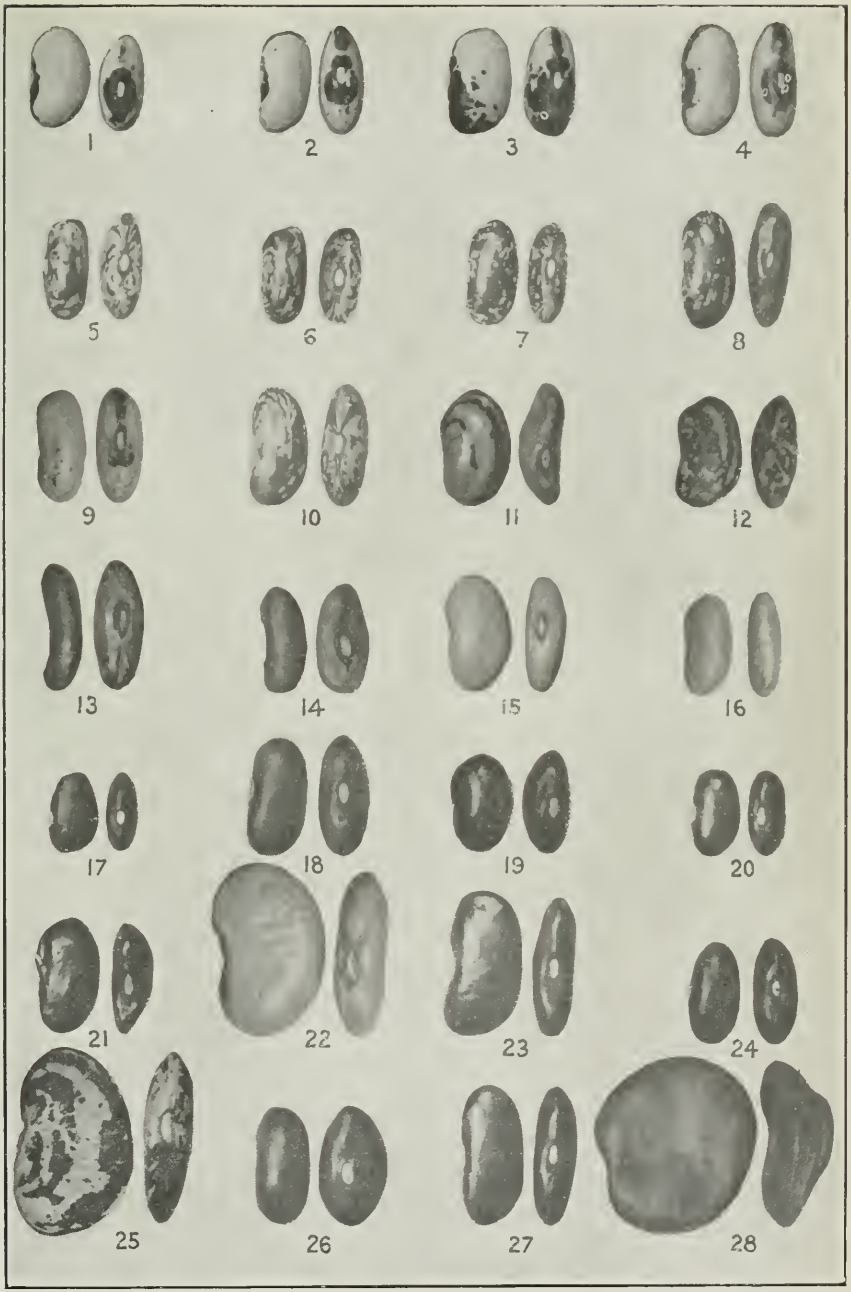

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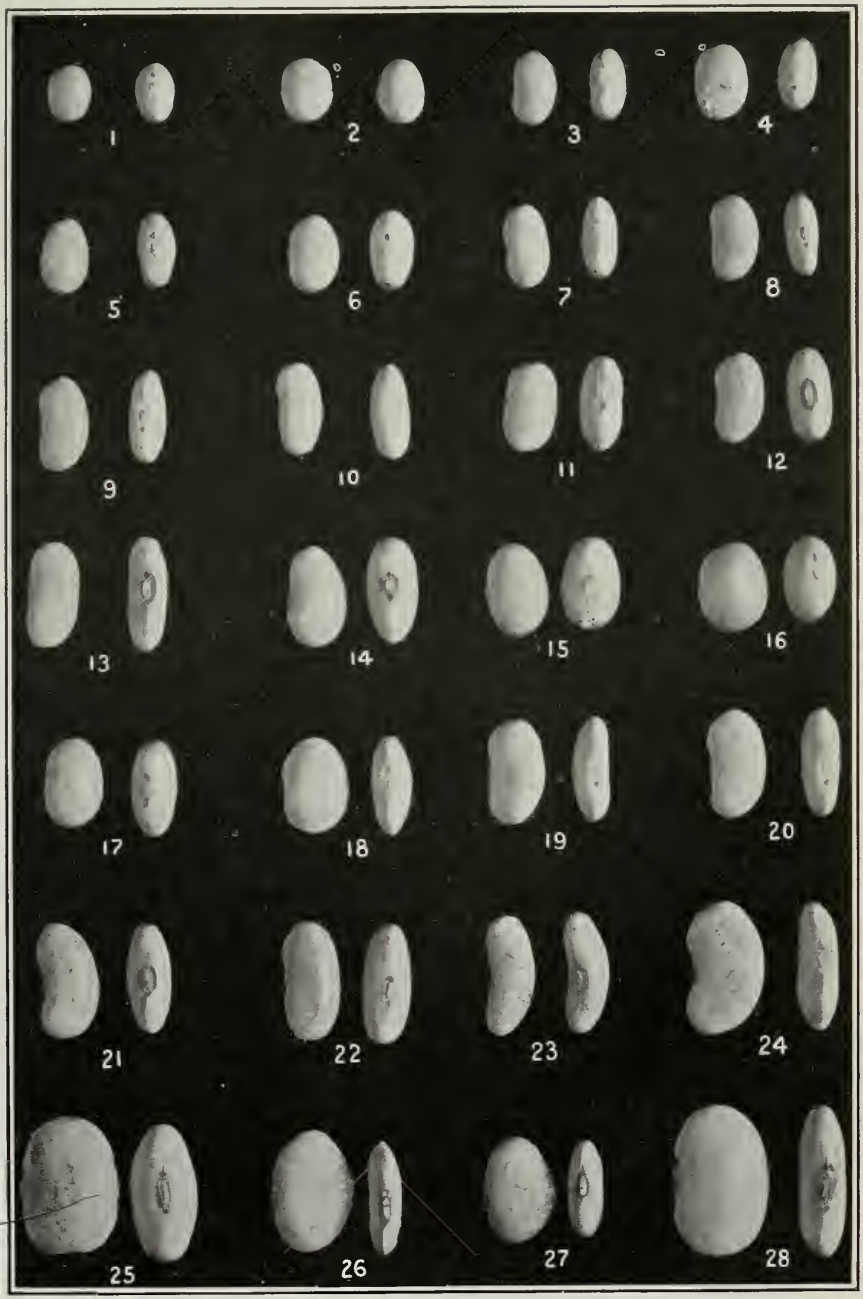
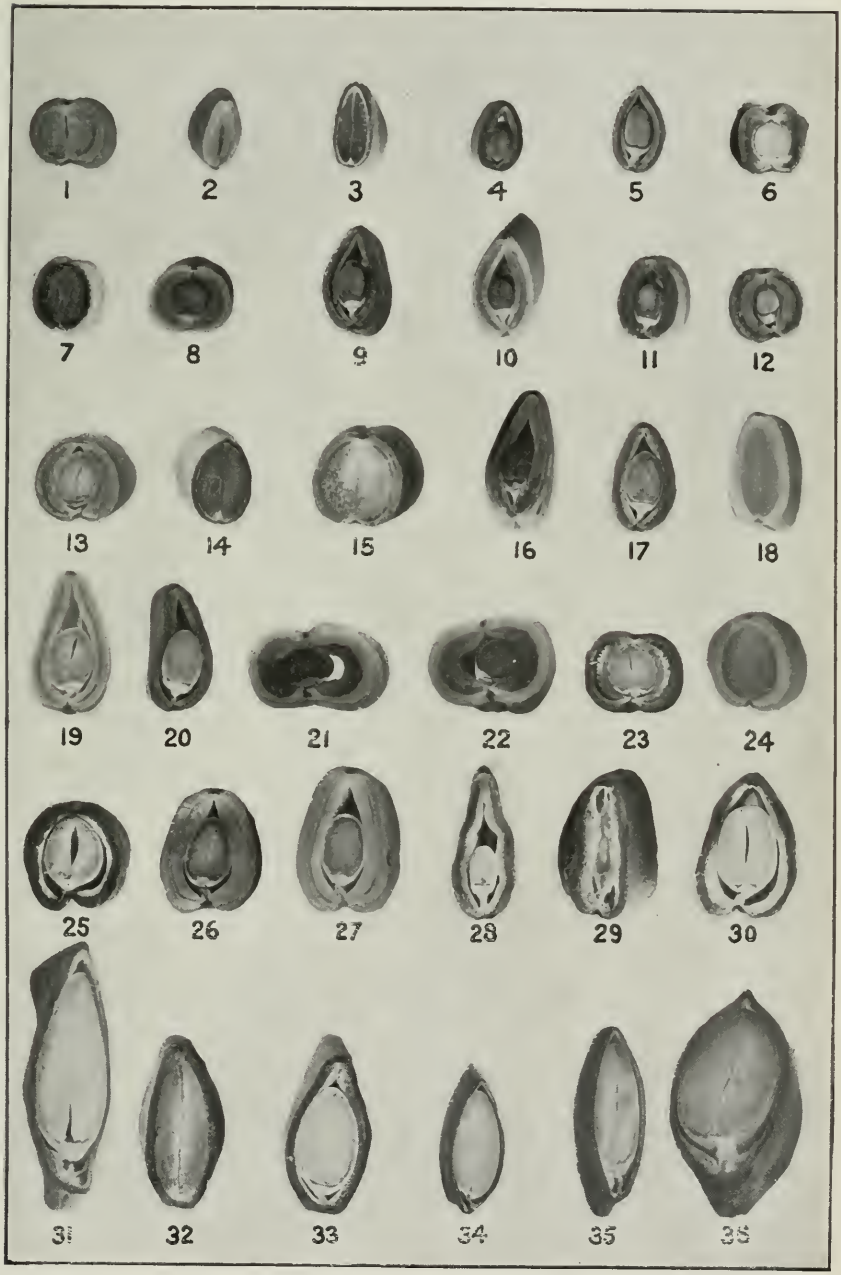


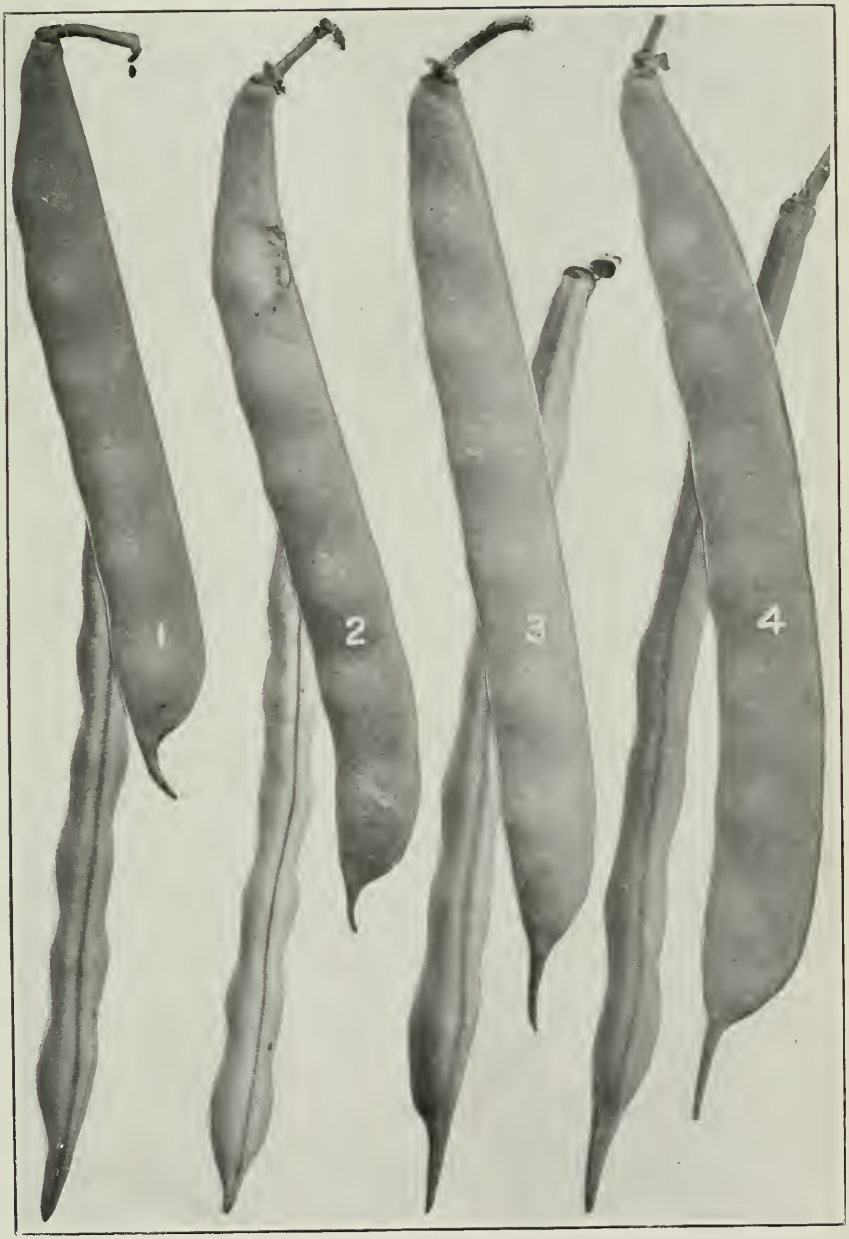
SIDE AND VENTRAL VIEWS OF RIPE WHITE SEEDS.

(Natural size.)



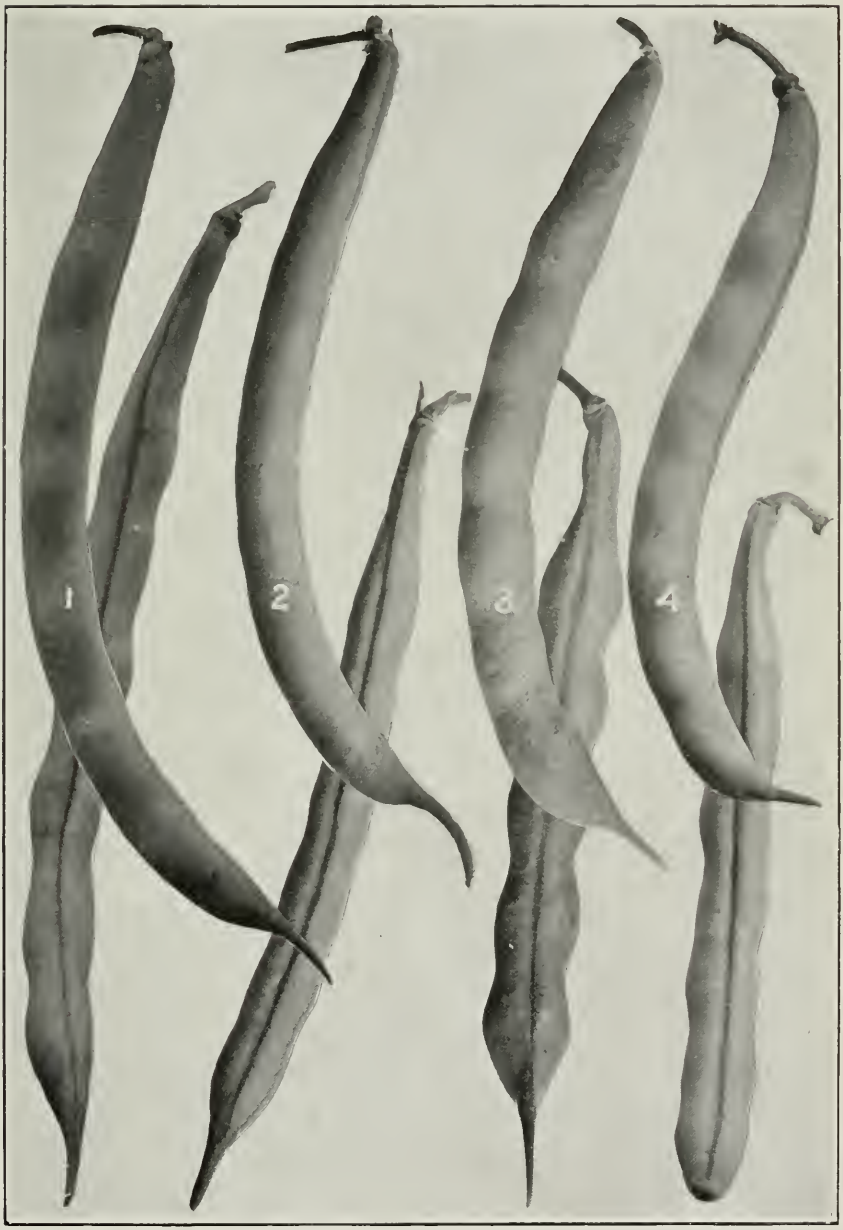
CROSS SECTIONS OF SNAP AND GREEN SHELL PODS.

(Natural size.)



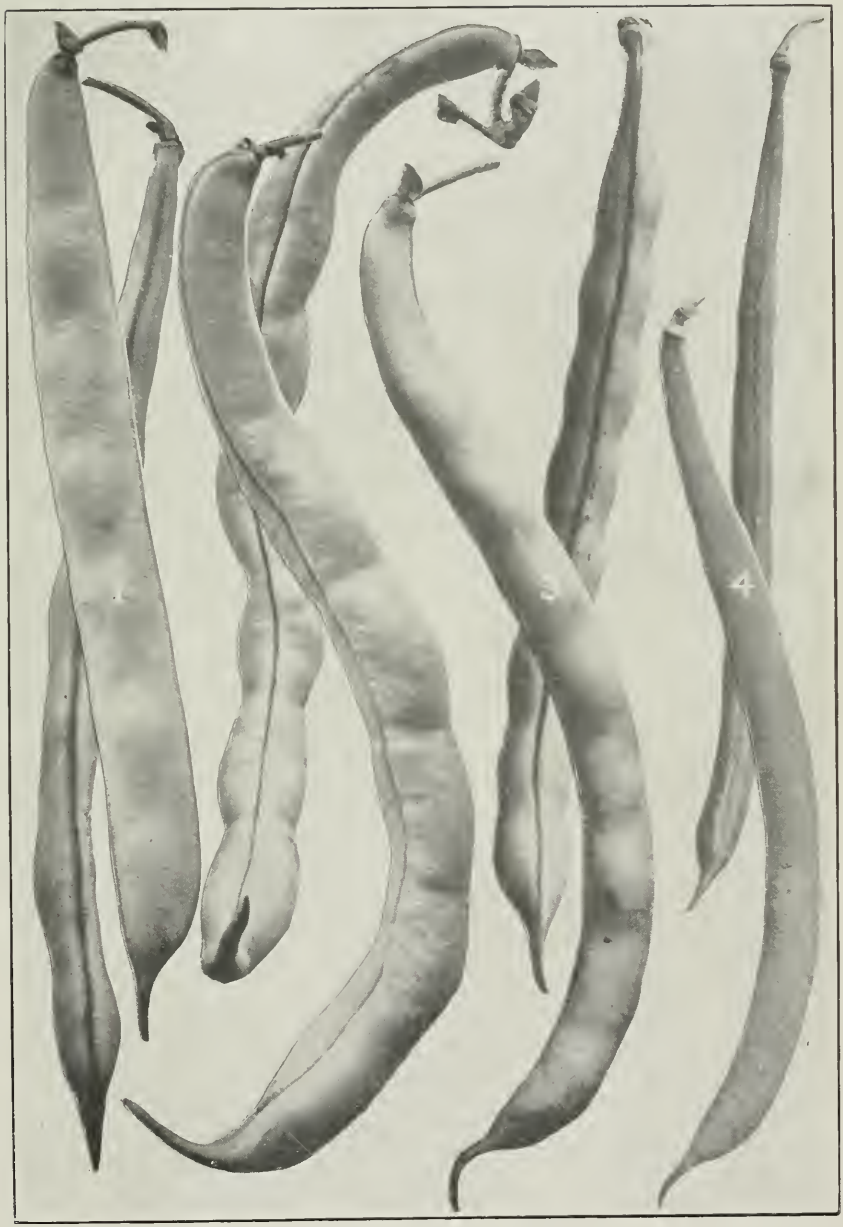
BUSH VARIETIES (SNAP PODS).

1.—Improved Golden Wax. 2.—Golden Wax. 3.—Horticultural Wax. 4.—Allan's Imperial Wax. (⅞ natural size.)



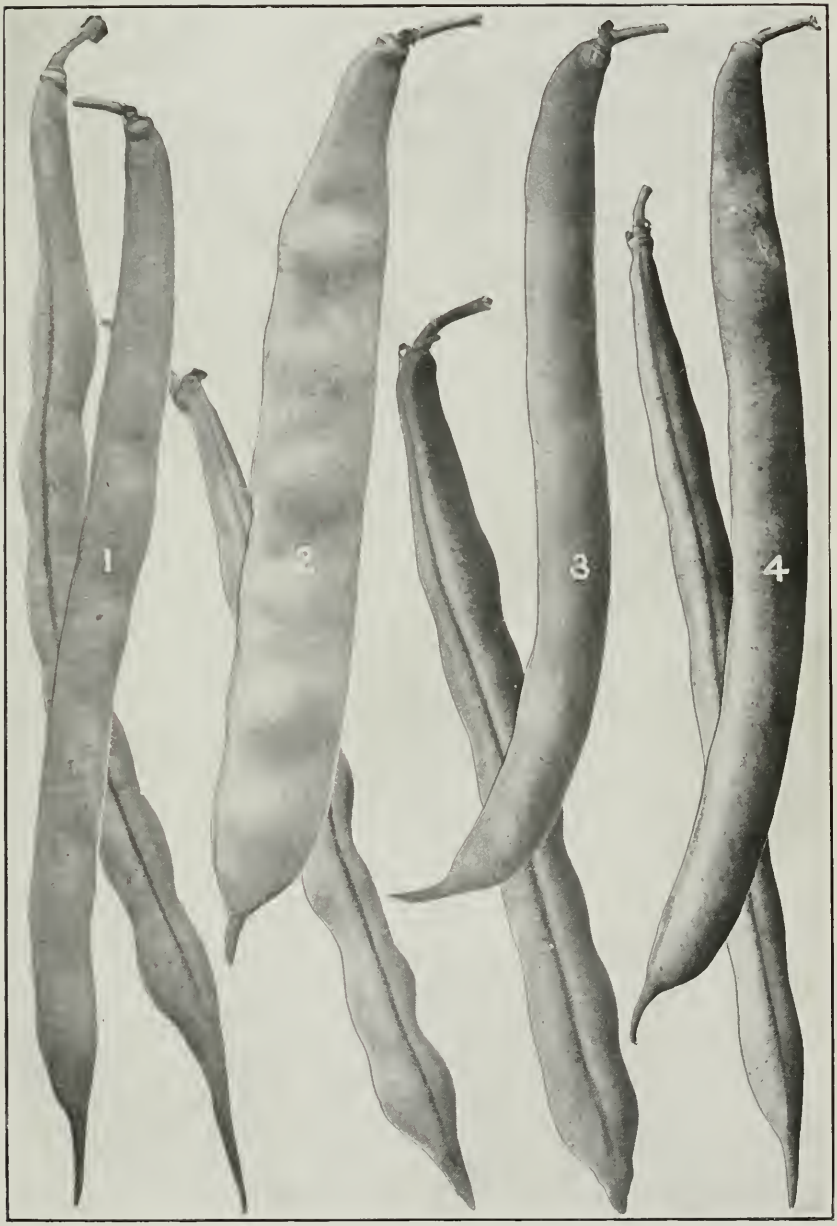
BUSH VARIETIES (SNAP PODS).

1.—Bismarck Black Wax. 2.—Extra Early Refugee. 3.—Red Valentine. 4.—Prolific Black Wax. (⅞ natural size.)



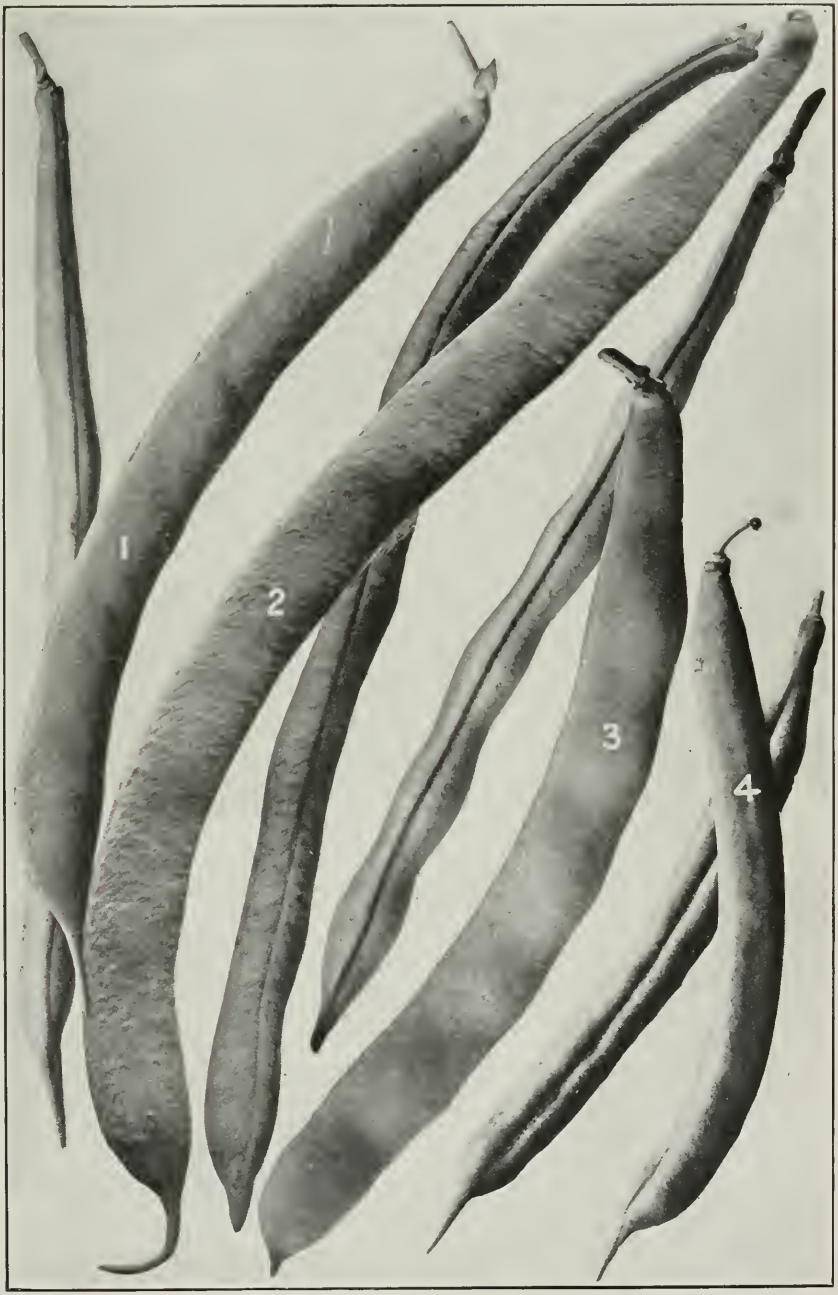
BUSH VARIETIES (SNAP PODS).

1.—Currie's Rustproof Wax. 2.—Yosemite Wax. 3.—Pencil Pod Black Wax. 4.—Triumph of Frames. (⅞ natural size.)



BUSH VARIETIES (SNAP PODS).

1.—Longfellow. 2.—Warren Bush. 3.—Burpee's Stringless Green Pod. 4.—Black Valentine.
($\frac{7}{8}$ natural size.)



BUSH VARIETIES (SNAP PODS).

1.—Long Yellow Six Weeks. 2.—Canadian Wonder. 3.—Wardwell's Kidney Wax. 4.—Yankee Winter Field.

(⅞ natural size.)

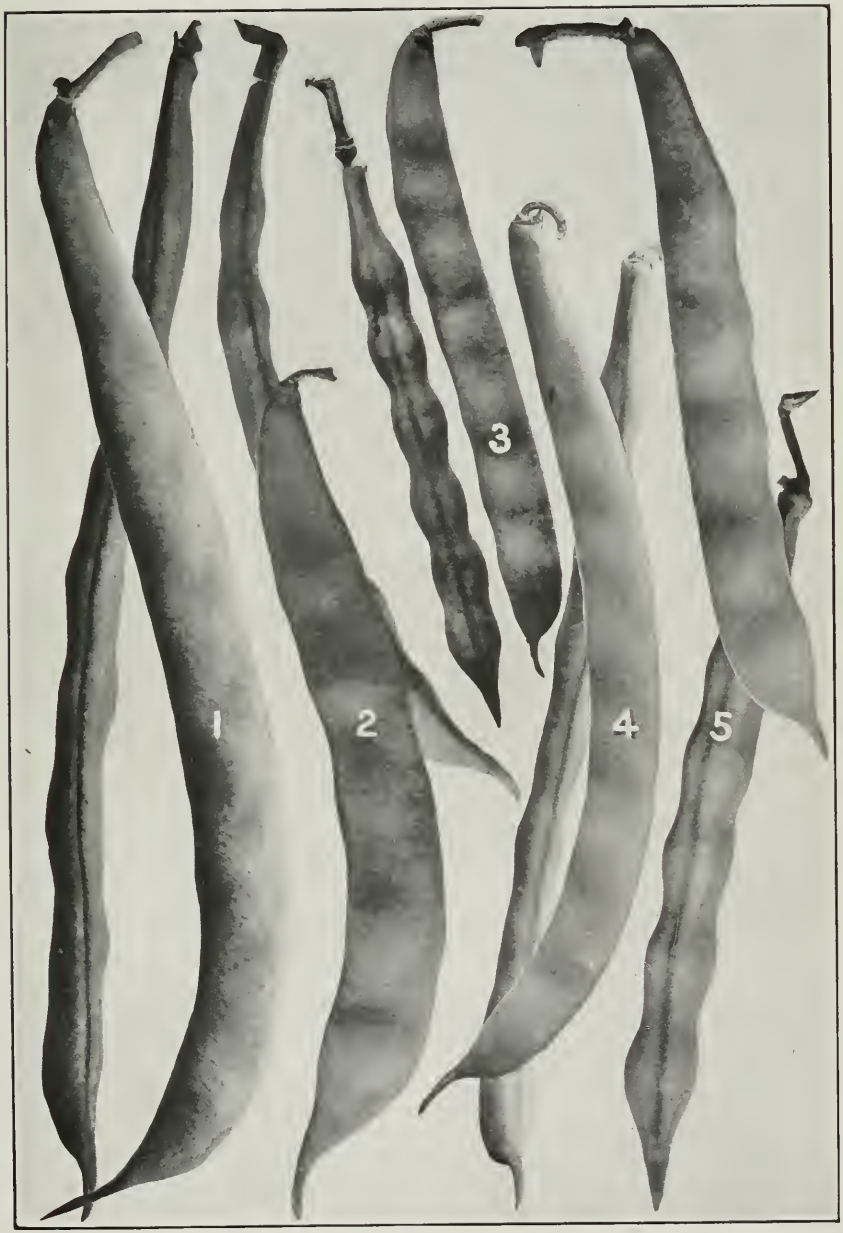
BUSH VARIETIES (SNAP PODS).

1.—Thorburn's Prolific Market. 2.—China Red Eye. 3.—Best of All (late type). 4.—Blue Pod Butter.

(⅞ natural size.)

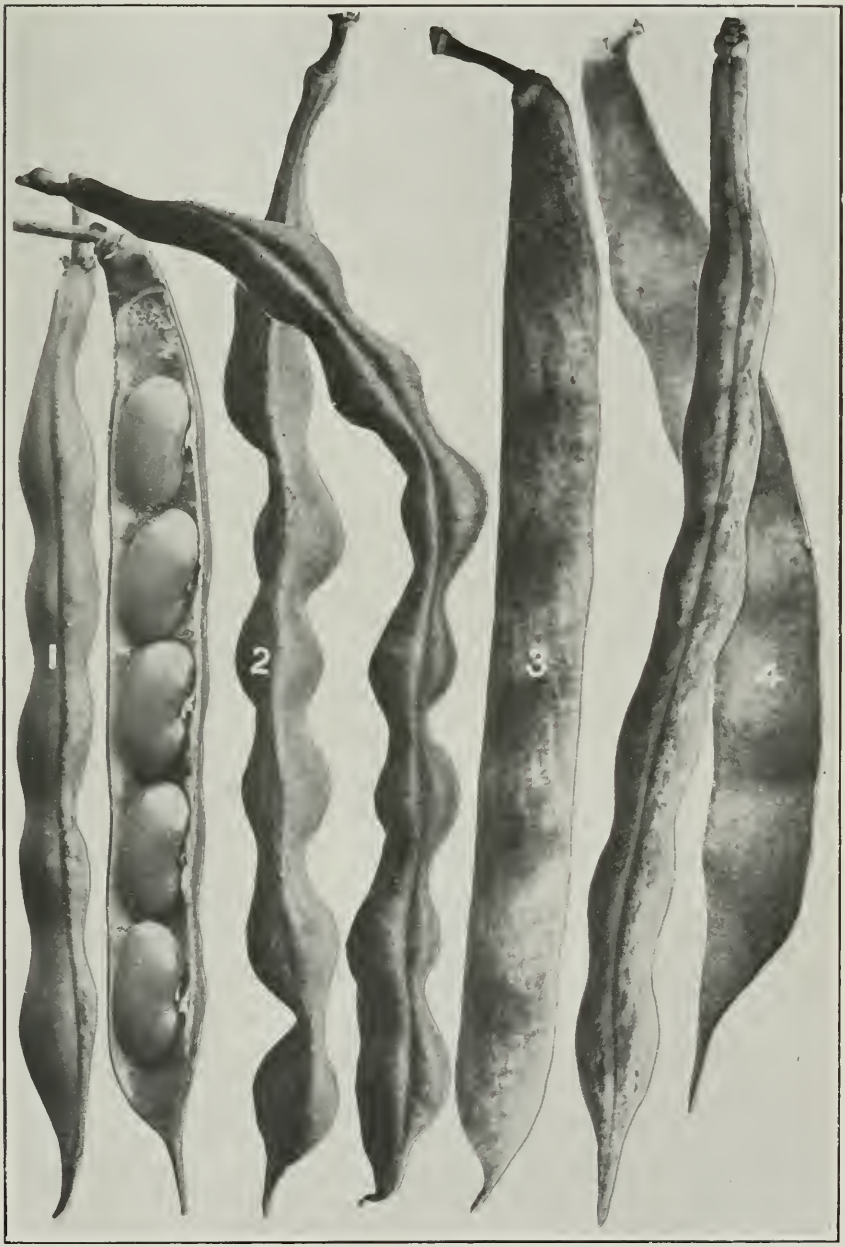
BUSH VARIETIES (SNAP PODS).

1.—Byer's Bush. 2.—Vienna Forcing. 3.—Refugee. 4.—Mohawk.
(⅞ natural size.)



BUSH VARIETIES (SNAP PODS AND GREEN SHELL PODS).

1.—Bountiful. 2—Lightning. 3.—Navy Pea. 4.—Black Turtle Soup. 5.—Round Yellow Six Weeks. ($\frac{7}{8}$ natural size.)



BUSH VARIETIES (GREEN SHELL PODS).

1.—Red Kidney Field. 2.—Tennessee Green Pod. 3.—Improved Goddard. 4.—Boston Favorite. (⅔ natural size.)

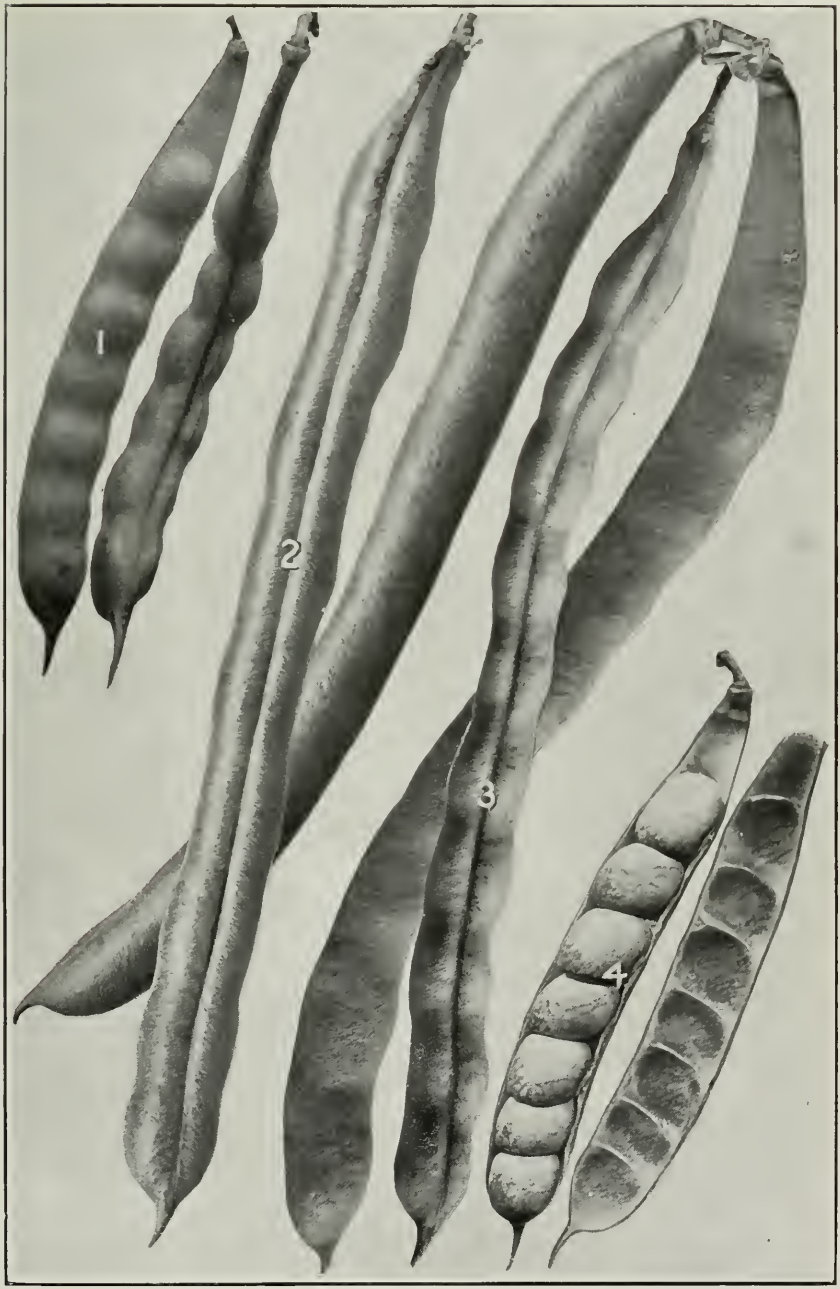
POLE VARIETIES (GREEN SHELL PODS).

1.—Extra Early Horticultural Pole. 2.—Kentucky Wonder Pole. 3.—Lazy Wife Pole. ($\frac{7}{10}$ natural size.)

POLE VARIETIES (GREEN SHELL PODS AND SNAP PODS).

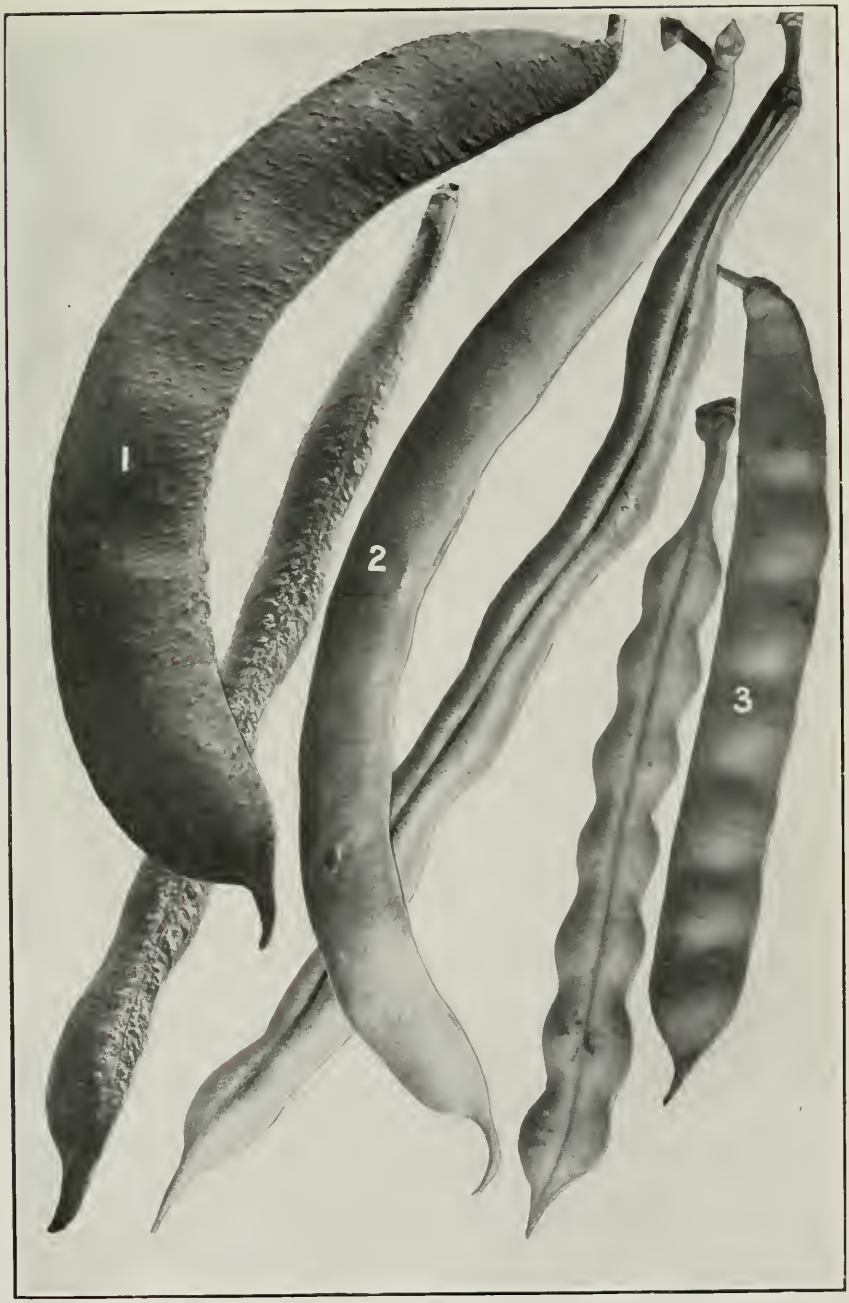
1, 2, and 4.—Types of Southern Prolific Pole. 3.—Kentucky Wonder Wax Pole. 5.—Golden Champion Wax Pole.

($\frac{7}{8}$ natural size.)



POLE VARIETIES (GREEN SHELL PODS AND SNAP PODS).

1 and 4.—Speckled Cut Short Pole. 2.—Scotia Pole. 3.—Black Kentucky Wonder Pole. ($\frac{7}{8}$ natural size.)

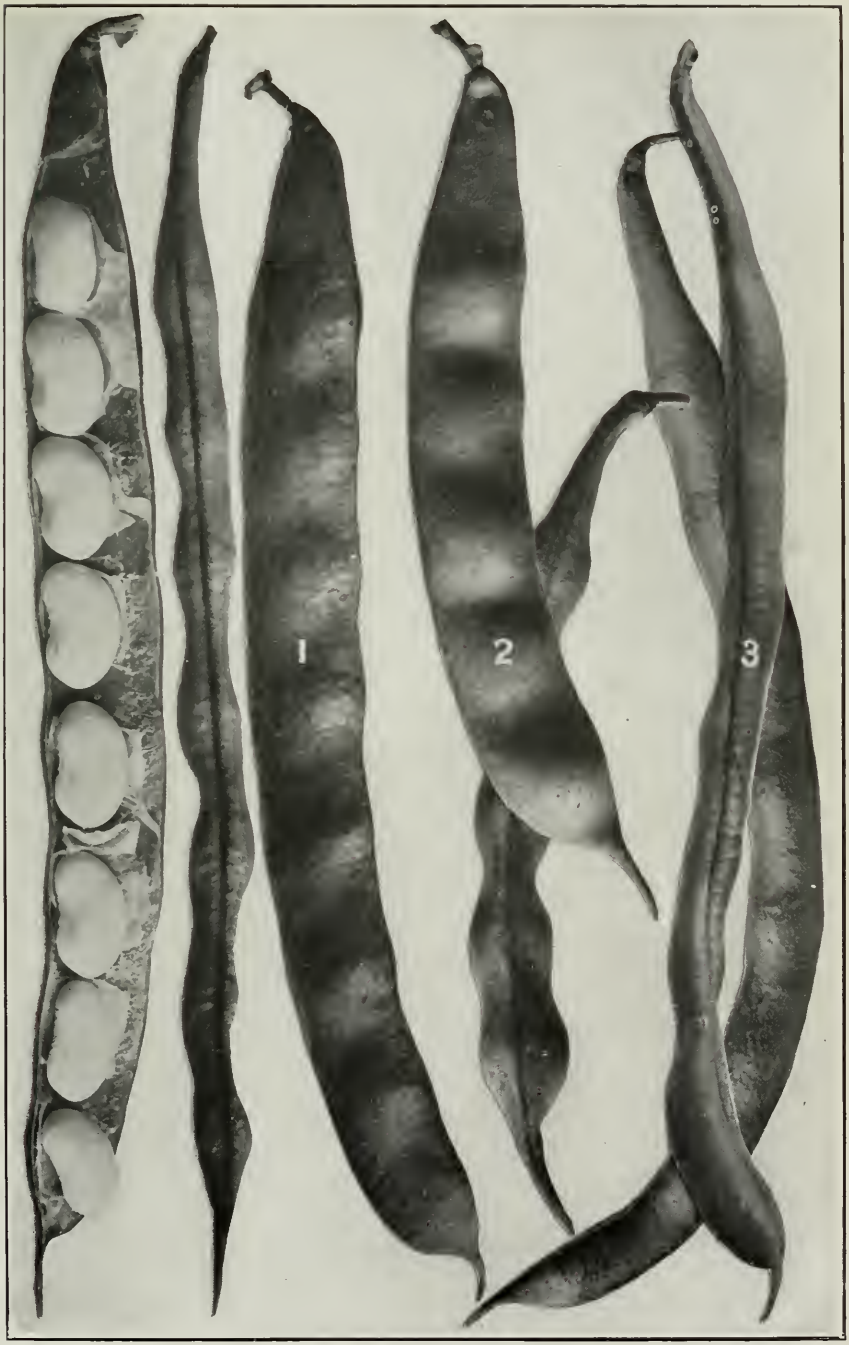


POLE VARIETIES (SNAP PODS AND GREEN SHELL PODS).

1.—White Dutch Runner Pole. 2.—White's Prolific Pole. 3.—Red Cranberry Pole.
($\frac{7}{8}$ natural size.)

POLE VARIETIES (GREEN SHELL PODS).

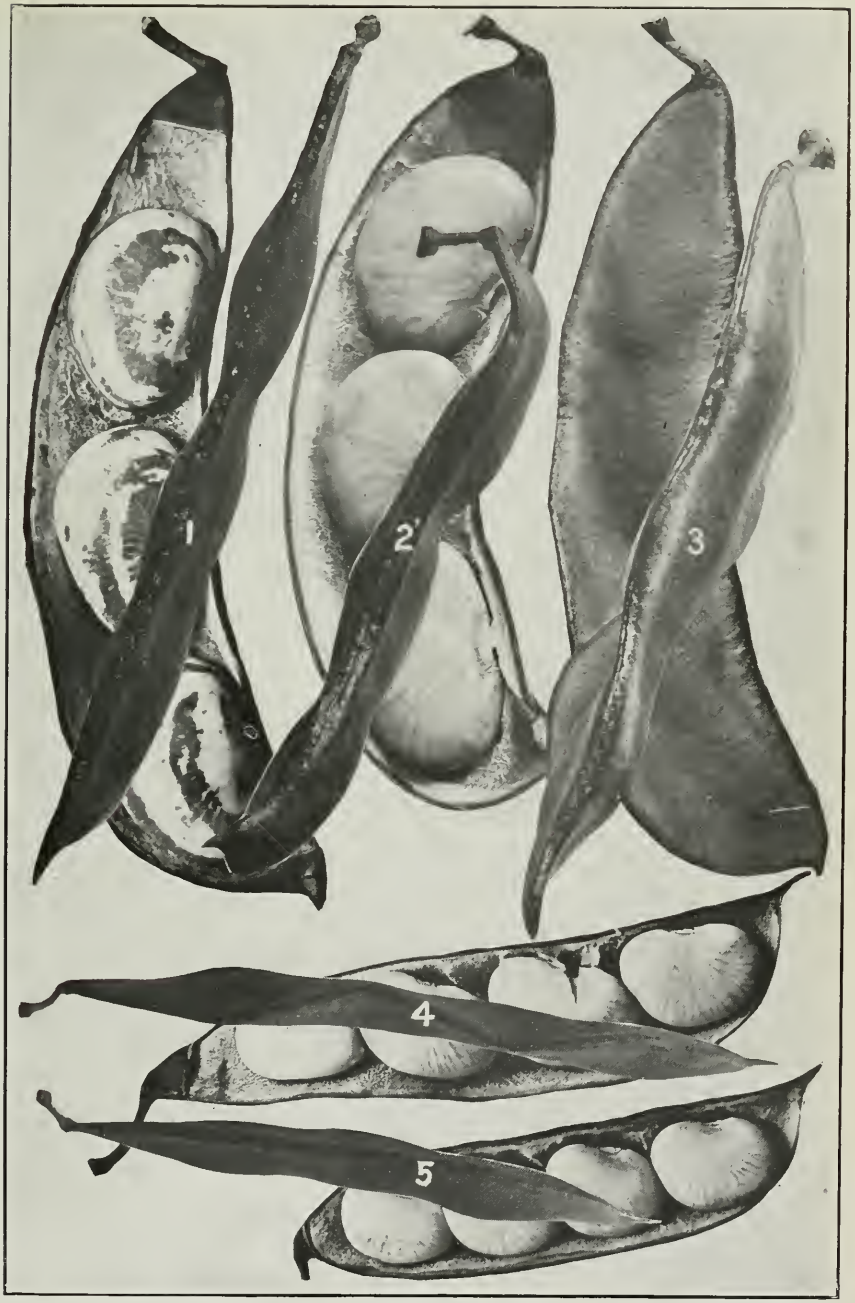
1.—White Creaseback Pole. 2.—Brockton Pole. 3.—Worcester Mammoth Pole.
(⅔ natural size.)



POLE VARIETIES (GREEN SHELL PODS).

1.—Dutch Case Knife Pole. 2.—Concord Pole. 3.—Royal Corn Pole.

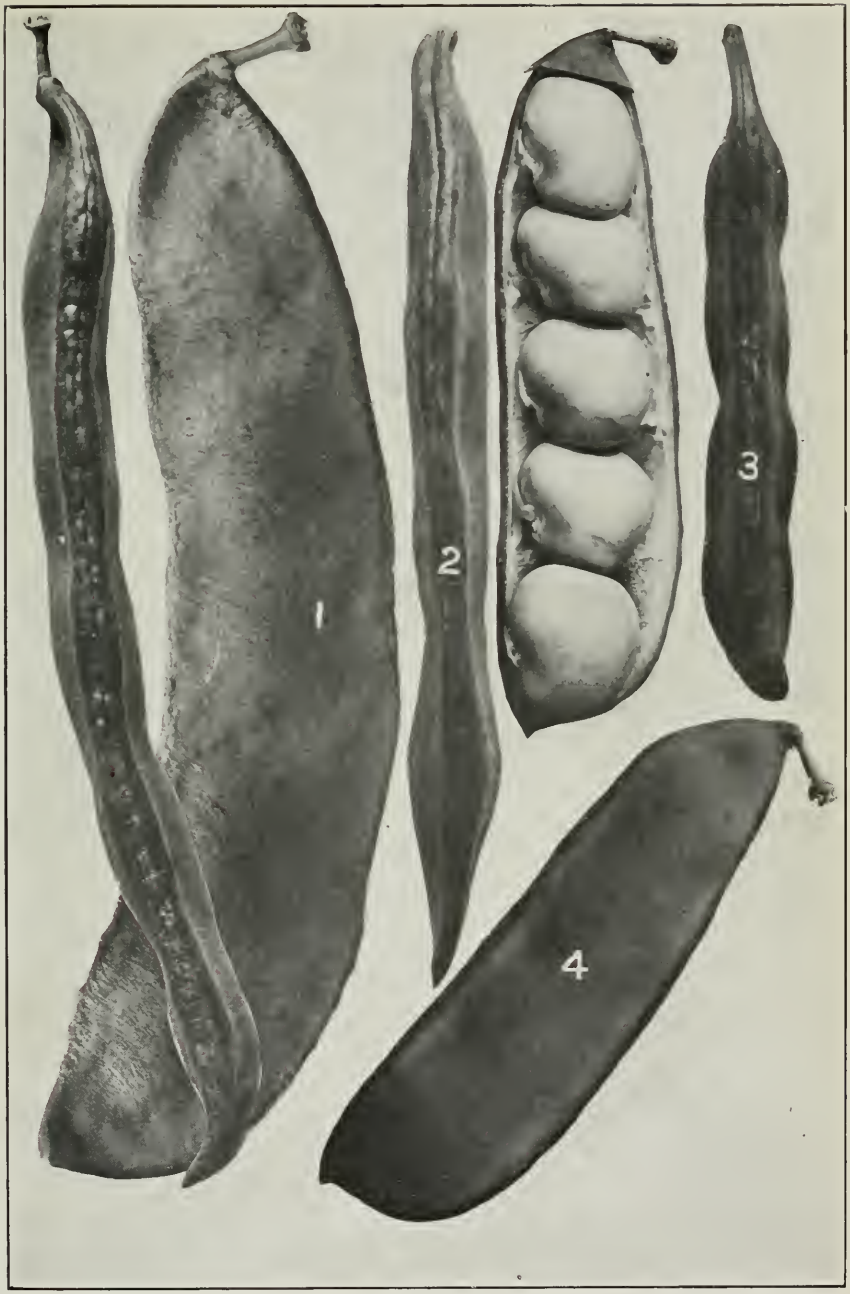
($\frac{7}{8}$ natural size.)



LIMA VARIETIES (GREEN SHELL PODS).

1.—Mottled Pole Lima. 2.—Burpee's Bush Lima. 3.—Seibert's Pole Lima. 4.—Wood's Improved Pole Lima. 5.—Small White Pole Lima.

(⅞ natural size.)



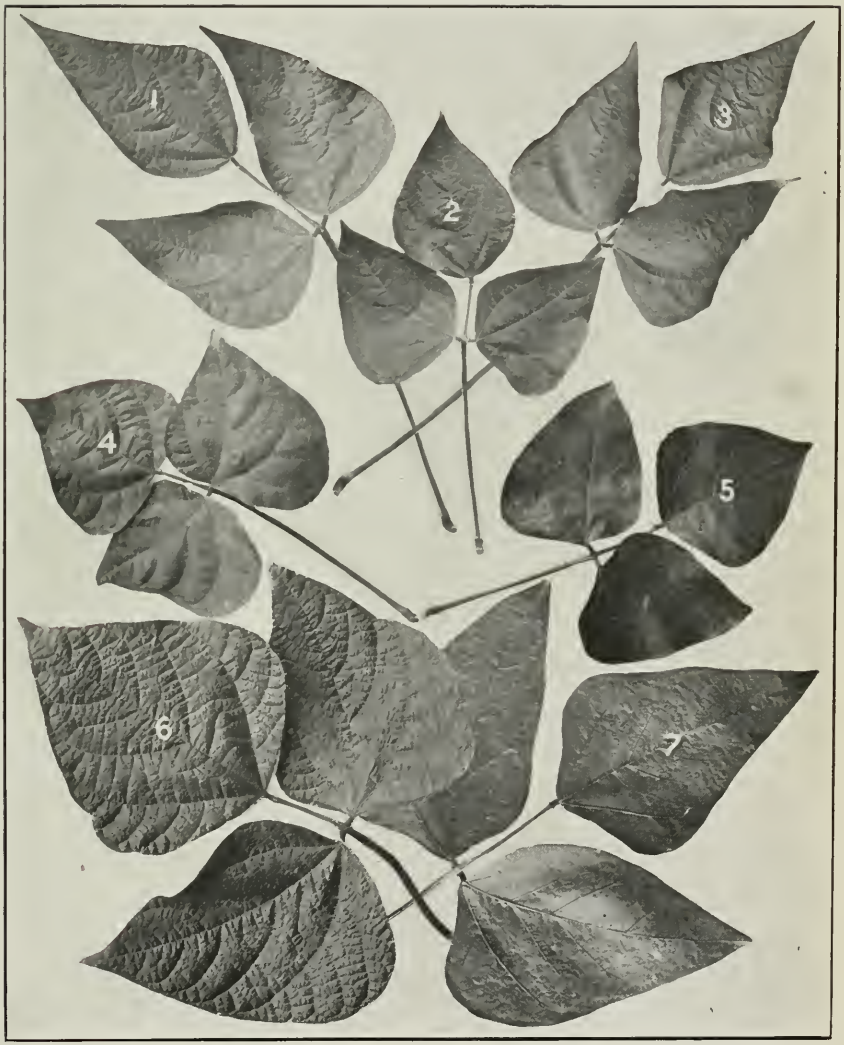
POLE LIMA VARIETIES (GREEN SHELL PODS).

1.—King of Garden Pole Lima. 2.—Leviathan Pole Lima. 3 and 4.—Dreer's Pole Lima. (⅞ natural size.)

LEAF TYPES.

1.—Keeney's Rustless Golden Wax. 2.—Willow-Leaved Pole Lima. 3.—Rogers's Lima Wax. 4.—Refugee Wax. 5.—Snowflake Field. 6.—Red Valentine. 7.—Ruby Horticultural Bush. 8.—Davis Wax.

(½ natural size.)



LEAF TYPES.

1.—Galega. 2.—Golden Wax. 3.—Golden Refugee. 4.—Blue Pod Butter. 5.—Small White Pole Lima. 6.—Canadian Wonder. 7.—Dreer's Pole Lima.

(¼ natural size.)

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BY

C. L. SHEAR,

PATHOLOGIST IN CHARGE OF INVESTIGATIONS OF DISEASES OF SMALL FRUITS.

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CRANBERRY SCALD.

U. S. DEPARTMENT OF AGRICULTURE.

BUREAU OF PLANT INDUSTRY—BULLETIN NO. 110.

B. T. GALLOWAY, *Chief of Bureau.*

CRANBERRY DISEASES.

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BY

C. L. SHEAR,

PATHOLOGIST IN CHARGE OF INVESTIGATIONS OF DISEASES OF SMALL FRUITS.

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LETTER OF TRANSMITTAL.

U. S. Department of Agriculture,
Bureau of Plant Industry,
Office of the Chief,
Washington, D. C., April 26, 1907.

Sir: I have the honor to transmit herewith, and to recommend for publication as Bulletin No. 110 of the series of this Bureau, the accompanying technical paper entitled "Cranberry Diseases," by Dr. C. L. Shear, Pathologist in Charge of Investigations of Diseases of Small Fruits.

This paper contains the first full account of the fungous parasites of the cranberry and the diseases they produce. It also gives successful methods of preventing the diseases.

The illustrations which accompany this paper are considered essential to a full understanding of the text.

Respectfully,

B. T. Galloway,
Chief of Bureau.

Hon. James Wilson,
Secretary of Agriculture.

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CRANBERRY DISEASES.

INTRODUCTION.

The American cranberry (*Vaccinium macrocarpum*) has been in cultivation for seventy-five years or more. The wild plant in its native habitat does not appear to be affected to any very noticeable degree by fungous parasites. Up to the present time only five species of fungi, according to the published host indices, have been reported as occurring upon this plant. It is generally the case, however, that the longer a plant is in cultivation and the greater the area covered by it the more numerous and serious are its parasites, since the conditions and opportunities for their development and distribution become much more favorable. This is true of the cranberry. At the same time, this plant by selection, cultivation, and growth under rather abnormal conditions has apparently become somewhat weakened and more susceptible to disease.

The cranberry is distributed from Newfoundland southward through the Alleghenies to North Carolina and westward into Wisconsin. It is also cultivated in a few localities on the Pacific coast, in Oregon and Washington. The native cranberry of that region is regarded by some botanists as a variety of *Vaccinium oxycoccus*.[1] [a]

The diseases of the cranberry are most serious in the southern sections of its area of cultivation. The losses from the various maladies are heaviest in New Jersey and decrease as one proceeds northward through Long Island, Connecticut, and Massachusetts, being least of all in the bogs of Nova Scotia. There is also comparatively small loss from disease at present in Wisconsin and on the Pacific coast. The annual crop of the United States approximates 1,000,000 bushels, valued at about $2,000,000. The loss from disease is estimated to average about 10 per cent, or $200,000 each year. From a careful study of the matter is seems probable that the climatic conditions are chiefly responsible for the greater amount of loss in the southern localities. The long, hot summers of the southern region seem to be unfavorable to the production of the most hardy cranberry plants

[a] The serial numbers used in this paper refer to the bibliography which will be found on pages 55 to 57.

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and at the same time most favorable for the development of the various parasitic fungi which attack them.

Several serious diseases have been found to be prevalent. They have nearly all, however, been heretofore included under one name by cranberry growers. All softening of the fruit, accompanied by more or less discoloration, has been called "scald" or "rot." This was quite natural, as the differences in the appearance of fruit attacked by the different parasites are so slight that it is difficult to distinguish between them by external examination.

There is no accurate record, so far as we have been able to discover, as to when the cranberry diseases first became sufficiently serious to cause much loss. Mr. J. J. White read a letter before the Cranberry Growers' Association in 1873 showing that the scald was known twenty years earlier, i. e., 1853. The diseases have probably spread more or less gradually as the fruit has become more widely cultivated.

PREVIOUS INVESTIGATIONS.

Cranberry scald was a frequent subject of discussion at the early meetings of the New Jersey Cranberry Growers' Association,[2] which was organized in 1869 and is now called the American Cranberry Growers' Association.

In 1874 Dr. Thomas Taylor, Microscopist of the Department of Agriculture, was sent by the Commissioner of Agriculture, at the request of the American Cranberry Growers' Association, to investigate the so-called cranberry "scald," which had for some years caused a great amount of loss on some of the New Jersey cranberry bogs. Doctor Taylor[3] published several articles giving accounts of his observations and studies. He concluded, as a result of his work, that the primary cause of the trouble was an excess of acid in the soil and water. He also believed that excessive heat and drought were important factors, causing a fermentation to take place in the fruit. He observed fungous filaments in the rotten or scalded berries, but did not consider this fact of much importance.

Taylor[3] says (Monthly Report, Dept. Agr., 1875, 446): "I am convinced that the scald and rot, so called, of the berry may arise from dissimilar causes, although chemically considered they are practically the same, viz, the conversion of their starch into grape sugar, a fermentable substance affording a nidus for the growth of fungi."

It will be seen from this quotation that the presence of a fungus was not considered the cause of the disease, but rather a secondary matter. Taylor believed that the trouble might be remedied by some application to the soil which would correct its acidity and prevent the fermentation in the fruit. In accordance with this sug-

gestion a considerable variety of substances was tried by the cranberry growers, including lime, copperas, salt, and sulphur. Little or no benefit, however, seems to have been derived from these applications, and the diseases continued to cause serious loss, varying somewhat in different seasons as the climatic and other conditions chanced to be favorable to their development or otherwise.

Schroeter,[8] in 1879, in discussing a sclerotium disease of the fruit of *Vaccinium myrtillus*, mentions the American cranberry disease which had been described by Taylor and expressed his belief that the trouble was due to a parasitic fungus, either the same or one similar to that which he found in Europe. He had seen no specimens, however. Supposing the disease to be due to Sclerotinia, he recommended the application of lime and suggested flooding the vines just before the spores are formed.

Woronin[9] in 1888 in treating of *Sclerotinia oxycocci* refers to the cranberry disease of the eastern United States and suggests that it is caused by this fungus. This opinion was not based on an examination of specimens, however, but on Doctor Taylor's accounts of the disease. If the disease were caused by Sclerotinia he thought it could be eradicated by collecting and burning all the mummied berries.

No species of Sclerotinia has yet been found on cranberries in the East so far as known, but, as will be seen later, one has been found in Wisconsin.

In 1889, Dr. Byron D. Halsted,[10] of the New Jersey Experiment Station, undertook a study of the cranberry diseases, and as a result published a bulletin and several briefer reports on the subject. Doctor Halsted[8] recognized the parasitic nature of the disease, and described and illustrated, without name, the two stages of the fungus which produces cranberry scald.. On account of his finding fungous hyphæ in the stems and roots of plants bearing rotten or scalded berries, he concluded that the parasite infested the soil and perhaps gained entrance to the plant, in part at least, by way of the roots. He consequently thought that remedies should be directed chiefly toward the improvement of soil conditions,[11] though later he recommended spraying with a solution of ammoniacal copper carbonate.[12] In his later publication[13] he says: "It seems well established that the fungus infests all parts of the plants and may enter the berry by means of the filaments which grow from the stem directly into the green berry, or by spores lodging upon the surface, the germ threads penetrating the fruit." Doctor Halsted[10] also investigated the cranberry gall disease, which will be referred to later.

Some work on cranberry diseases has also been done at the Wisconsin Agricultural Experiment Station. This will be referred to later in discussing the diseases.

In 1901, at the urgent request of the American Cranberry Growers' Association and in cooperation with the New Jersey Experiment Station, a study of cranberry diseases on behalf of the Bureau of Plant Industry was commenced by the writer. Both field and laboratory investigations have been continued since as the pressure of other duties would permit. Careful studies were first made of the field conditions, and laboratory and greenhouse studies have been made of the diseases found and the fungi producing them.

THE MOST SERIOUS DISEASES.

Cultures of the fungi found in diseased berries soon showed that, instead of a single disease, the term "scald" as used by cranberry growers includes at least three distinct diseases of the fruit—scald, rot, and anthracnose—caused by three different fungous parasites, *Guignardia vaccinii* Shear, *Acanthorhynchus vaccinii* Shear, and *Glomerella rufomaculans vaccinii* Shear. Besides the diseases which affect the more or less mature fruit there is another, commonly called "blast," or sometimes "blight," by the cranberry growers, which attacks the very young berries about the time the blossoms fall, causing them to turn black and shrivel up. There is also a disease which causes hypertrophy of the axillary leaf buds, and thus exhausting the vitality of the plant prevents the production of fruit. The most important diseases of the cranberry are those mentioned. Besides these there are a number of diseases of minor importance which will receive briefer consideration.

BLAST.

As already mentioned, the blast attacks the flowers and very young fruit, which shrivels up and becomes covered with the pycnidia of the parasite (Pl. II, figs. 1*a*, 1*b*). It frequently happens that as much as one-half of the crop on some bogs or portions of bogs is destroyed in this manner. The disease is caused by the pycnidial form of *Guignardia vaccinii* Shear.[24] The blasting of young fruit had been observed for many years by cranberry growers, but apparently the fungous nature of the disease was not known. There is, of course, some blast, or blight, of blossoms and of very young fruit due to other causes, as imperfect fertilization or injury by storms, frost, or insects, but by far the greater part of the blasted fruit on New Jersey cranberry bogs is due to the above-mentioned fungus.

Whitson, Haskins, and Malde[15] mention a cranberry "blight" which occurs in Wisconsin, killing the blossoms and very small fruit. This trouble, according to the writers mentioned, has been attributed by growers to hot weather. The results of their experiments were

contrary to this theory. They concluded from their trials with several fertilizers that the blight depended largely upon the vitality of the vines. Plats treated with phosphates showed least blight. In conclusion they say: "The agent of destruction of these blossoms is probably a bacterial or fungus growth which takes place only under a devitalized or weakened condition." Having had no opportunity to make a study of the blight, or blast, in Wisconsin, we are unable to say how much of it may be due to *Guignardia vaccinii*, which produces the blast, or blight, in the East. From the fact that this fungus occurs in Wisconsin and destroys more or less of the fruit, it is highly probable that some of the blight, or blast, is also caused by it. The "blossom blight" is also mentioned by Whitson, Sandsten, Haskins, and Ramsey.[16] They state that a treatment for blight of three applications of Bordeaux mixture produced an increase of 30 per cent in the crop of fruit over that on adjacent vines not treated. This would seem to indicate that the disease is of a fungous nature.

SCALD.

The term "scald" is one which has been in general use among the New Jersey cranberry growers for a long time. It originated as a result of a view previously held by many growers that the softening of the diseased fruit was due to an actual scalding of the berry, caused by the hot sunshine when the berries were wet.

A condition somewhat resembling the effect of the fungus does sometimes occur when berries have been overflowed and covered with water for half a day or more during hot weather, but injury of this kind is infrequent and unimportant.

The first indication of the attack of the scald fungus upon the cranberry is the appearance of a minute, light-colored, watery spot upon its surface. This, under favorable conditions, rapidly spreads, usually in a concentric manner, until finally the whole berry becomes soft (Pl. I). Frequently the diseased area is marked by concentric dark-colored rings. This, however, is not always the case, and is not especially characteristic of this disease, as it sometimes occurs in the case of the cranberry rot. In very rare instances only a small, light-colored sunken spot is produced upon the berry, the fungus by some unknown cause having been retarded or entirely prevented from further development. In such cases we occasionally find the pycnidia of the scald fungus present, as illustrated by Doctor Halsted[10] in his work on cranberry scald. Ordinarily, however, there is no indication on the surface of the fruit of the presence of a fungus, except for occasional dark blotches or brownish zones, as mentioned above. Berries which are attacked before they are half grown usually shrivel up and become blackened and covered with

the pycnidia of the scald fungus (Pl. II, fig. 1, *b*, and Pl. VI). This form of the disease is called blast, as already described.

The disease also affects the leaves, occasionally causing an irregular reddish brown spot, covering a portion of the leaf, and bearing pycnidia or perithecia of the fungus. These spots are of very infrequent occurrence. Where the disease has been severe for a number of years the plants are completely killed, and the dead, brown leaves still hanging to the vines are usually covered on the under surface with the minute fruiting bodies of the parasite (Pl. II, fig. 1).

Cuttings the first year or two after planting and before fruiting are sometimes seriously attacked by *Guignardia vaccinii*, which causes the leaves to turn yellow and fall and finally kills the plant. Some of the other cranberry fungi are also associated with this injury, but the greater part of the damage is apparently due to the scald fungus.

THE FUNGUS (GUIGNARDIA VACCINII, SHEAR) CAUSING BLAST AND SCALD.

Scalded or rotten berries so rarely show any fruiting forms of fungi that it is necessary to determine their presence and identity by careful microscopical examination and cultures. A microscopic study of the softened tissues of scalded berries at once reveals the presence of an abundance of fungous hyphæ. These hyphæ when transferred to culture media grow readily and frequently produce the fruiting forms of the fungus. This fungus, *Guignardia vaccinii* Shear,[24] which has been found upon blasted berries, upon the leaves of scalded vines, and isolated in numerous cases in pure cultures from scalded fruit, has been grown in the laboratory for several years.

Whitson, Sandsten, Haskins, and Ramsey[16] state that the cranberry scald in Wisconsin is caused by an unnamed species of Rosellinia. We have never found any fungus of this genus associated with cranberry scald or any other disease of the cranberry in Wisconsin or elsewhere. The only cranberry fungus which at all resembles Rosellinia is *Anthostomella destruens* Shear, which has been found only once in our investigations, and then in New Jersey. The true scald fungus (*Guignardia vaccinii*) has, however, been found in Wisconsin berries. There are two stages thus far known in the course of its development, a pycnidial and an ascogenous stage.

Pycnidial form.—The pycnidia are minute, black, membranous, globose receptacles, 100–120 μ in diameter, provided with a minute apical, sometimes slightly prominent ostiole, or mouth. When occurring on the leaves they are situated beneath the epidermis, usually on the under side, and are slightly erumpent, with the minute ostiole

exposed. In most cases they are thickly and evenly distributed over the surface of the leaf, except for the infrequent occasions when only a portion of the leaf has been killed by the fungus (Pl. II, figs. 1 and 2). Mature pycnidia contain great numbers of pycnospores, bearing at their apexes a rather inconspicuous appendage consisting of granular matter, which appears to be embedded in a somewhat gelatinous substance. They are borne on short, simple sporophores 10–15 μ long. These pycnospores are hyaline, obovoid, with the apex frequently truncate, and measure from 10.5 to 13.5 by 5 to 6 μ. The appendage is usually about the length of the spore, or somewhat less, and curved (Pl. II, fig. 3, *a*, *b*, *c*). At maturity these pycnospores are expelled from the pycnidium in a small gelatinous tendril or threadlike mass, being held together by the gelatinous substance of the spore appendages as well as the free gelatinous matter which appears to be produced within the pycnidium and forms a thin layer about the pycnospore.

Ascogenous form.—The ascogenous perithecia are much less frequently found than the pycnidia. The perithecia resemble the pycnidia very closely in form, size, and other characteristics (Pl. II, fig. 10). In fact it is almost or quite impossible to determine, in the absence of asci or pycnospores, to which form a particular fruiting body may belong. The perithecia seem to have a denser, somewhat more opaque wall than the pycnidia, and they contain oblong, or somewhat clavate, short-stipitate, or sessile asci, the spore-bearing portion varying from 52 to 60 by 9 to 12 μ, the total length being 60 to 80 μ (Pl. II, fig. 11). The asci contain eight hyaline, or, when old, slightly yellowish brown, short elliptical or subrhomboid ascospores, having the contents rather coarsely granular (Pl. II, fig. 12). They vary in size from 13 to 16.5 by 6 to 7 μ. No paraphyses have been found. The characters of the ascogenous form of this fungus seem to agree most nearly with those of the genus Guignardia and correspond very closely to the black-rot fungus of the grape (*Guignardia bidwellii* (Ell.) V. & R.). The pycnidial stage of *Guignardia bidwellii*, as described and illustrated by Viala [18] and others, differs from the pycnidial stage of the cranberry scald fungus in scarcely any particular except in the absence of the spore appendage. A recent careful study of fresh pycnidia of *Guignardia bidwellii* shows that its pycnospores also bear a similar appendage. It is, however, shorter and less easily distinguished than that of *Guignardia vaccinii*, and soon disappears in mounted specimens. The appendage in the case of the cranberry fungus is very constant and characteristic.

The cranberry scald fungus is rather generally distributed throughout the cranberry-growing sections of this country. Pycnidia have been found on either leaves, flowers, or fruit in West Virginia, New

Jersey, Massachusetts, Nova Scotia, Wisconsin, and New York, and perithecia in New Jersey and New York.

CULTURES OF GUIGNARDIA VACCINII.

Over 200 cultures from hyphæ, pycnospores, and ascospores have been made upon artificial media of various kinds. The first cultures of the fungus were made from hyphæ taken from the interior of scalded berries. The berries were first thoroughly washed and soaked in a 1 to 1,000 solution of corrosive sublimate ($HgCl_2$), and a portion of the pulp containing the fungous hyphæ was transferred with sterile needles to the culture medium.

The following culture media have been used: Cylinders of potatoes and of beets; steam-sterilized and dry-sterilized cranberry leaves and cranberry fruit; cranberry agar and cranberry gelatin, prepared by adding various proportions of cranberry juice to agar and gelatin; beef agar and sugar-beet agar; corn meal saturated with cranberry agar; corn meal saturated with cranberry gelatin; malta vita saturated with cranberry agar, and corn meal saturated with distilled water. It appears to grow equally well upon acid and neutral media.

We have had the greatest and most uniform success in the use of corn meal and water sterilized in an autoclave for about fifteen minutes. The fungus also grows readily on corn meal saturated with cranberry agar, corn meal saturated with cranberry gelatin, and on potatoes. It grows more slowly and less luxuriantly on most of the other media tried.

Pycnidial form.—Cultures producing the pycnidial form have been made from the pulp and skin of diseased fruits in thirty-eight different cases and from leaves in two instances. This form has also been grown from pycnospores. The mycelium in all cases is at first thin, floccose, and white. In a few days it becomes denser and takes on a bluish gray color. As the culture gets older the hyphæ spread concentrically and the mycelium loses its bluish tint and becomes grayish brown. Pycnidia begin to appear in four to eight days, and mature pycnospores can usually be found in twelve to eighteen days. The pycnidia form a more or less continuous layer on the surface of the somewhat felty subiculum formed by the mycelium. They are frequently inconspicuous on account of the velvety surface growth of hyphæ, with which the mycelial layer is covered. In the majority of cultures made from hyphæ taken from diseased berries only pycnidia are produced, and in many instances the culture has all the characteristics of growth and appearance of *Guignardia vaccinii*, but is either entirely sterile or produces sclerotia-like bodies resembling pycnidia externally but containing no spores.

Ascogenous form.—Cultures producing both pycnidia and asci have been obtained in five cases by transplanting the fungous hyphæ from diseased berries, and in three cases from affected leaves, to culture media.

The first successful culture was made from decaying fruit obtained in the Washington market. The source of the fruit is unknown, but it was probably from New Jersey. The culture was made on March 31, 1902. The berries used were softened; the skin was light colored and watery and showed small dark-colored blotches of fungous hyphæ on the inner surface. Two cultures were made from one of these berries by transferring portions of the pulp containing the hyphæ to flasks of cranberry agar and corn meal. The cultures were kept in the laboratory at the ordinary temperature, which varied from 16 to 25° C. The course of development and appearance of the fungus were the same as in the cultures producing pycnospores only, as previously described. Mature pycnidia were produced in about twelve to fifteen days, and at the end of twenty-two days a great abundance of ascogenous perithecia was found. There is nothing in the macroscopic appearance of a culture bearing ascogenous perithecia to distinguish it from one bearing only pycnidia. The ascogenous perithecia are practically identical in appearance with the pycnidia. In mature and old cultures the color of the mycelium becomes dark brown, or almost black, and the pycnidia or perithecia become more exposed on the surface of the subiculum or crustlike stroma.

The second successful culture of the ascogenous form was made January 20, 1903, by transferring a portion of the skin of a diseased berry showing darkened spots to a flask of water-saturated, autoclaved corn meal. The course of development was the same as in the culture just described. Many bodies resembling pycnidia were produced at first, but all examined were apparently sterile. Later, in addition to these sterile bodies, ascogenous perithecia of Guignardia were found.

The third successful culture of ascogenous perithecia was made December 23, 1903, from diseased New Jersey berries, which had been kept in ordinary storage in an unheated building in the Department. These berries showed the ordinary appearance of scalded fruit, and the cultures were made by transferring sections of diseased berries which had been washed and soaked in a solution of corrosive sublimate to flasks of sterilized corn meal. An abundance of fertile pycnidia was produced, and at the end of nineteen days perithecia containing mature asci were found.

The fourth successful culture was also made at the same time as the last mentioned, and from fruit from the same source, treated in the same manner.

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The fifth successful culture from diseased berries was made May 10, 1904. The berries were received from Cranmoor, Wis. They were softened and shriveled and showed definite black spots on the surface. After washing and soaking for three-fourths of an hour in corrosive-sublimate solution, sections of the diseased portion, including the skin, were transferred to large tubes of sterilized corn meal. About one month later ascogenous perithecia of Guignardia were found in this culture. Several other cultures made at the same time upon the same culture medium and from fruit having the same appearance produced only pycnidia. Transfers made from cultures producing asci to sterile potato cylinders have produced the ascogenous form as quickly and abundantly as when grown on corn meal.

Besides the successful cultures just described, which have been made from diseased berries, we have, in three instances, obtained from cranberry leaves pure cultures bearing both pycnidia and asci.

On March 23, 1905, cultures were made by placing in flasks of sterile corn meal leaves which had been first soaked for about one hour in a 1 to 500 solution of corrosive sublimate and then cut in two pieces. These leaves were taken from vines which had borne very badly scalded fruit during the previous season. The vines were collected on November 29, 1904, and kept in an ice box from that time until the cultures were made. The leaves were of 1903 growth and were to all external appearances healthy and free from fungi. Leaves taken from this collection in March, 1906, still produced plenty of good pycnidia and ascogenous perithecia. The course of development of the fungus in these cultures was identical with that described in the other cases. Pycnidia were produced in abundance in about fifteen days, and at the end of twenty-nine days ascogenous perithecia were found in three of the cultures.

From these original cultures many others have been made by transfer. Four generations have been grown in this way, producing both pycnospores and ascospores in each. After this the fungus appeared to have lost its vitality and did not grow well. In other cases it developed both spore forms for one or two generations only.

The fresh pycnospores of this fungus germinate and grow readily in water, in a dilute solution of sugar and water, and in ordinary culture media. Spores placed in a drop culture of sugar water in the laboratory began to show signs of germination at the end of two days. The germ tube usually arises from the side of the pycnospore, first forming a slight enlargement, which rapidly elongates into a germ tube and soon begins to branch (Pl. II, figs. 4 to 9). At the end of four days many of the germ tubes have attained considerable length. The tube occasionally arises from the basal end of the spore (Pl. II, fig. 6), but we have never seen it arise from the apical end, where the

appendage is borne. The mycelium now grows more rapidly and soon assumes the color and other characteristics mentioned in the description of the macroscopic appearance of cultures of the fungus.

The appendage of the pycnospore, as seen upon immature spores, consists of a hazy, hyaline, finely granular, gelatinous mass, equaling the spore in diameter (Pl. II, fig. 3). A little later it becomes somewhat elongated, curved backward, and more or less appressed on the side of the spore. As the spore matures the appendage becomes still narrower and free from the side of the spore, but even at maturity it is usually somewhat curved. In old cultures which have passed maturity and in which all the spores have been set free, the appendage is frequently wanting and seems to have been dissolved or disintegrated.

No signs of a conidial form of the fungus have been found in any of the numerous cultures made, either from the mycelium or spores. No chlamydospores have been found in cultures, but what appear to be such are found in old berries destroyed by the fungus. Sterile pycnidia or perithecia are frequently found, especially in poorly developed cultures. These are sometimes solid and sclerotoid, with the interior cells lighter colored, and are about the same size as the pycnidia and perithecia.

CONDITIONS OR FACTORS DETERMINING THE PRODUCTION OF THE ASCOGENOUS FORM.

The reasons for the rare occurrence of ascus-bearing forms in cultures of what are undoubtedly ascomycetous fungi have always been obscure, and it has usually been found impossible to produce the ascogenous fructifications with much frequency or certainty.

The work of Klebs[19] and others upon the effect of various nutrient and other substances upon the production of sexual fructification, especially in the algæ, has suggested the possibility of such factors having a determining influence on the production of the ascogenous stage in this fungus. While our experiments in this direction have been comparatively few, there has been no indication that the composition of the culture medium is of particular importance in this respect. When once an ascus-producing race, strain, or generation of the fungus was obtained it grew almost equally well upon different culture media, such as steamed corn meal, cranberry gelatin and corn meal, cranberry agar and corn meal, and potatoes.

The effect of variations in temperature has also been tried upon a series of pycnospore-producing cultures made from the same original pure culture. Cultures in flasks on corn meal were kept in the laboratory, where the temperature varied from 20° to 26° C. Others were kept in a thermostat at a temperature of 30° C. Others

have been kept in a refrigerator at a temperature of about 3° C. The cultures kept in the laboratory made the most rapid and vigorous growth of mycelium, those in the thermostat and refrigerator growing about one-half as fast. All these cultures finally produced pycnidia, but no signs of asci were ever found.

Experiments have also been tried to determine the effect of different quantities of moisture. The fungus was found to grow more rapidly on a rather wet medium, but there is no indication that this influences the production of the ascogenous stage of the fungus.

Other experiments were tried to determine the effect upon the growth and development of the fungus of varying the amount of available air and the evaporation by plugging the culture flasks more or less tightly. Little or no difference was noticeable in the growth in these flasks, and only pycnidia were produced.

The work of Blakeslee [20] on Mucor and the factors controlling the production of zygospores in that and related genera has suggested the possibility that the sexual or ascogenous fructification might arise from the union of different races or individuals. The few experiments we have made along this line, however, have been unsuccessful.

It has been thought by Brefeld [21] that ascus formation may depend upon the time of the year, or possibly the period of development of the fungus in its host. Our investigations, however, are not conclusive in regard to these points, so far as they concern *Guignardia vaccinii*. Cultures have been made from fruit and leaves taken almost every month during the year, and it will be noted that cultures which produced the ascogenous stage of the fungus were made in January, March, May, and December. Many other cultures, however, made during these same periods and from leaves and fruit in which the fungus had presumably passed through approximately the same period of development were either sterile or produced pycnidia only. While we have no cultures made from material taken during the summer which have produced ascospores, this may be due to the fact that comparatively few cultures have been made from leaves or fruit during that season.

In regard to the bearing of the duration of development of the fungus upon the production of asci, we have no means at hand of determining, except by mere conjecture, the age of the fungus which may be present at any particular time in the tissues of cranberry leaves or fruit, not knowing positively when the infection took place and the germ of the fungus entered the plant. All the evidence at hand, however, points toward June and July as the time.

As a result of our work, we are led to the belief that there is some inherent potentiality in the mycelium of the fungus in certain strains,

races, or generations which causes it to produce the ascogenous stage whenever conditions for its growth are favorable, i. e., on favorable culture media without special reference to their exact composition or environment or on the leaves of its natural host. Whether this potentiality depends on some preceding union of nuclei from different or the same individuals, or some equivalent stimulus, we are, of course, unable to say. It appears possible, however, that there may be such a factor concerned.

DORMANT CONDITION OF THE FUNGUS.

Leaves and berries which, so far as can be discovered by external examination, are perfectly sound are very frequently found to contain the fungus. Leaves perfectly normal in appearance, taken from vines growing in diseased areas, have been thoroughly washed and soaked from fifteen minutes to two hours in a solution of corrosive sublimate, 1 part to 500 parts of water, in order to destroy any fungous spores which might possibly be present upon their surfaces. These leaves were then placed in sterile, moist chambers. After a period of eight to twelve days an abundance of the pycnidia of *Guignardia vaccinii* was found to have developed upon the leaves, and in some instances these were followed by the ascogenous form of the fungus. Berries apparently perfectly sound and healthy have also been treated in the same manner, and in many cases the characteristic decay of the fruit has followed. Cultures made from the pulp of these berries have produced the fruiting forms of the Guignardia.

So many experiments of this kind have been tried that we feel convinced that the fungus must be present within the tissues of the leaves and berries referred to in a dormant or more or less inactive condition. It does not seem possible that any spores could resist the action of the corrosive sublimate solution used. Tests which have been made show that the spores of *Guignardia vaccinii* are killed by being immersed in a 1 to 1.000 solution of corrosive sublimate for five minutes. A great number of microtome sections of leaves and fruit supposed to contain the dormant form of the fungus have been studied. It has been found very difficult to demonstrate the presence of the fungus and to determine its form, chiefly, perhaps, on account of unsatisfactory results in differential staining.

In case of the berries, carefully stained sections have shown what appear to be cells of fungous hyphæ just beneath the epidermis. In both leaves and fruit the fungus seems to be able to exist in the tissues in a more or less inactive or dormant condition while awaiting an opportunity for further development; such opportunity is apparently afforded by any conditions which weaken the cranberry plant and also by those which are favorable to the growth of the

fungus, such as sufficient heat and moisture. If a similar condition of affairs should prove to obtain rather generally among similar parasitic fungi, as seems to be possible from observations and experiments made with other cranberry diseases and several anthracnoses on different hosts, it will have an important bearing upon the results and conclusions derived from ordinary infection experiments in which plants have been used which were not grown from uninfected seed under conditions which would preclude possible infection at any time previous to their use. It would also have an important bearing upon the value of inferences regarding the time of infection based upon the time of the outbreak of the disease.

It has been supposed that in the case of diseases such as the black-rot of the grape the time of its external destructive appearance followed within a short period after the germs of the disease had entered the tissues of the plant. In other words, it has been taken for granted that as soon as a germ tube gains entrance to the tissues of its host it proceeds to develop under normal conditions and soon produces its characteristic injuries. On the contrary, however, it seems much more probable that there is no regular period of incubation, but that the development of the parasite depends largely upon the conditions surrounding it and its host. If the host plant becomes weakened in any way or if the conditions of heat and moisture are especially favorable for the fungus its development may be rapid and continuous, but if these conditions do not obtain the fungus may remain in an inactive or dormant condition, or its development may be very slow or intermittent and in some cases perhaps entirely suppressed. Many illustrations of this condition can apparently be found among foliicolous pyrenomycetes which develop their fruits so abundantly during the winter on old fallen leaves. There is no evidence, so far as we know, that infection of these leaves takes place during the winter. The scanty observations which have been made indicate rather that the mycelium is present in the leaves when they fall, though there is no outward indication of its presence.

TIME AND MANNER OF INFECTION.

We have been unable thus far to discover exactly when and in what manner infection of the leaves and fruits takes place. The pycnidial form of the fungus may be found within from ten to fifteen days after the water with which the vines are usually flooded during the winter has been removed. This appears to be about the normal period required for the development of the pycnidia when the growth of the fungus is regular and continuous, as shown by its growth and development in pure cultures. The pycnidia appear first upon old leaves of vines which have apparently been weakened or killed by the

disease. A great number of pycnospores are also produced about the 1st of July upon the very small blasted berries. These are probably the chief source of the infections which follow. The pycnospores may also be found more or less abundantly during the whole season upon old dead and dying leaves, especially of those vines which have been cut and broken.

The ascogenous form is apparently not of very frequent occurrence. It has been collected occasionally on old leaves from June to November, but, judging from the small quantity found, it does not seem probable that it is a very important factor in the general distribution and spread of the disease. Ascospores in most pyrenomycetous fungi appear to be produced normally in late winter and spring. The abnormal conditions under which the cultivated cranberry is grown—the plants being generally flooded with water from November until May—prevent the production of the fruiting forms of the fungus during that period. We have found by laboratory experiments that the fungus does not develop upon leaves when they are kept immersed in water. Twigs with leaves from vines bearing very badly scalded fruit have been kept in water in the laboratory for months without any external indication of the development of the fungus, while leaves from the same plants kept in moist chambers developed Guignardia in abundance. In the early stages of our investigation various inoculation experiments were tried, both in the field and in the greenhouse, using plants which were presumably free from disease, judging from the external appearance of the vines and berries. The results of these experiments have, however, since been shown to be valueless on account of the quite general occurrence of the fungus in leaves and fruit which appeared normal and healthy, as already pointed out. In order, therefore, to make conclusive infection experiments it is necessary to grow plants from seed in sterile soil under conditions which will prevent possible infection from any source except artificial inoculation. Thus far we have been unable to do this, owing to the fact that great difficulty has been experienced in germinating seeds and growing satisfactory plants in the greenhouse. From field observations made in connection with our spraying experiments it seems very probable that infection of the young leaves takes place very early in the season, soon after the water is removed from the bog and as soon as the first generation of pycnospores is produced upon the old dead and fallen leaves. There are also observations and facts which seem to indicate that infection of the berries generally takes place when they are rather young. This is self-evident of course in the case of the blasted fruit, which is destroyed when it is very small. Attempts to infect mature or nearly mature fruit in the laboratory have in all cases been unsuccessful.

Fresh pycnospores have been placed in drops of water upon fruit kept in sterile moist chambers, but without any noticeable result. The spores germinate, but are apparently unable to penetrate the epidermis of the fruit. That infection of the foliage and fruit instead of taking place in whole or in part by way of the roots and up through the stems, as supposed by Doctor Halsted, arises from external sources seems to be proved by the very satisfactory results of spraying experiments and by the observations already recorded. Several tips of vines bearing leaves, collected September 15, which had been thoroughly sprayed during the season, were carefully washed with corrosive sublimate and placed in sterile moist chambers. A few fungi developed in a very few of these leaves. Other leaves, collected at the same time from adjacent vines which had not been sprayed, were treated in the same manner. These were found to be completely infested with fungi, and the pycnidia of Guignardia developed in abundance on almost every leaf.

A considerable quantity of fruit which had been sprayed was treated in the same manner as the leaves already mentioned. As a result, 1,200 sprayed berries picked on September 18 showed on October 18 but 9.8 per cent of diseased fruit, while the same number of unsprayed berries from the same source kept under the same conditions in the laboratory for the same period showed 38.1 per cent of diseased fruit. The only explanation of these results in the light of our present knowledge of the effect of Bordeaux mixture is that most of the spores of the fungus had been destroyed by the spraying and therefore did not gain entrance to the leaves and fruit.

TREATMENT.

Applications to the soil.—Acting upon the supposition that the cranberry scald was primarily due to unfavorable soil conditions or to fungi attacking the plant by way of the root system, chemicals or fungicides to be applied to the soil were suggested as a remedy by Doctor Taylor,[4] and later they were tried by Doctor Halsted.[11] Lime, plaster, salt, sulphur, copper sulphate, and iron sulphate were tried in different quantities. No decided benefit is reported to have resulted from these applications.

Improving the condition of the plants.—It is a matter of general observation that the cranberry scald is much more serious on certain bogs or portions of bogs than on others. The conditions obtaining in the soil and water of these diseased areas no doubt have much to do with the prevalence of the disease. The factors concerned are so complex, however, that it is difficult to demonstrate satisfactorily exactly what they are and which are of greatest importance. The experience of various growers appears to show that the control of the

water supply is an important factor. The cranberry plant is naturally water loving and grows in its wild condition in the sphagnum bogs of deep swamps. When it is cultivated in open meadows and without a constant and sufficient water supply it quite naturally becomes weakened and susceptible to disease. In order to keep the plants in a thrifty condition the water supply should not only be sufficient but well controlled, so that the moisture may be kept near the surface during the growing season. In many cases there are local soil conditions which interfere with the healthy growth of the plants.

The practice of applying a thin layer of sand to the surface of the bog every few years is quite general in Massachusetts and is believed to tend to keep the plants in a thrifty and vigorous condition. In New Jersey this practice is not so common and the beneficial results where it has been tried do not seem to have been so apparent as in Massachusetts. The practice of sanding, since the sand would cover all the fallen diseased leaves and many of the old dead vines, would tend to prevent the development and spread of the spores and might prove beneficial in this way, if in no other. It is also desirable as a sanitary measure to rake out and destroy all dead and dying plants. The fungus *Guignardia vaccinii* produces its spores in great abundance upon such plants, and these, therefore, serve as a source of distribution for the parasite. All such dead and diseased matter should be destroyed by burning, preferably in the fall of the year.

Selection of resistant varieties.—It has been frequently observed that even in the most diseased areas of cranberry plants there is an occasional vine bearing fruit which appears to be free from disease. It seems probable, therefore, that by the selection and propagation of such plants a variety might be produced which would show a very considerable degree of resistance to this disease. As the cranberry is generally reproduced by cuttings, the propagation of a resistant variety would be simpler and more likely to succeed than in the case of plants propagated by seed.

Application of fungicides.—As already stated, Doctor Halsted[11] recommended spraying with ammoniacal copper carbonate. He also reports[4] trying several fungicides, including Bordeaux mixture and potassium sulphid, making two applications of each. No benefit from these applications was observed.

After determining the parasitic nature of the cranberry scald, the relationship of the parasite, and the probable manner of infection, it seemed reasonable that the disease should be prevented by the proper use of fungicides. In our first experiments the ammoniacal copper carbonate solution, potassium sulphid solution, and Bordeaux mixture were used. As very little benefit was apparently derived from the use of the two fungicides first mentioned, later

experiments were made with Bordeaux mixture only. In the spraying work of 1904 [25] the results showed an average of 21.7 per cent of diseased fruit on the sprayed plats, while on the unsprayed check plat there was an average of 76.8 per cent diseased. The circumstances under which this was done were such, however, that the applications could not be made at proper intervals. During the next season (1905 [26]) the work was done more thoroughly and the results were far more satisfactory. As a result of five applications the sprayed plats averaged 2.36 per cent of rotten berries, while the unsprayed check plats averaged 92.6 per cent of rotten fruit. The 6–6–50 formula for Bordeaux mixture was used and 4 pounds of resin-fishoil soap were added. It was found that the plain Bordeaux mixture did not spread properly over the surface of the fruit and foliage, and also did not adhere well. In order to correct these defects the soap was added and was found to give most satisfactory results. The cost of spraying as done in these experiments averaged from $15 to $20 per acre, the mixture being applied at the rate of 4 barrels, or 200 gallons, at each application. Success in preventing this disease by spraying depends largely upon the care and thoroughness with which the preparation is made and applied. In our last experiments the 5–5–50 formula was used, and with thorough work it has been found to give as satisfactory results as the 6–6–50 mixture.

ROT.

The term "rot" is here applied to a decay of the cranberry caused by a fungus which we have recently described as a new genus and species (*Acanthorhynchus vaccinii* Shear).[24] The appearance of the fruit attacked by this disease is not sufficiently peculiar or characteristic to satisfactorily distinguish it from scald or anthracnose by its external or internal appearance. The rot first appears as a small, light-colored, soft spot on the berry, finally softening and destroying the whole fruit. In the later stages of its development it very frequently produces small, dark-colored blotches on the inner surface of the skin. So far as has been observed, the fungus never produces spore-bearing fructifications upon the berries. The only way in which this disease can be positively diagnosed is by making a culture from the mycelium of the fungus taken from the interior of the affected fruit.

The disease attacks the leaves also, but the fungus is very rarely found in a fruiting condition except on those which have fallen to the ground. Judging from the frequency with which this fungus appears in cultures made by transplanting the fungous hyphæ from decaying berries, the injury caused by it is second only to that produced by the scald. Though this disease is most frequent and destruc-

tive in New Jersey, it has also been found in West Virginia, Massachusetts, Wisconsin, and Nova Scotia.

THE FUNGUS (ACANTHORHYNCHUS VACCINII, SHEAR) CAUSING THE ROT.

The fungus producing the rot differs in several respects from any species which we have been able to find described. The rarity of its occurrence in a fruiting condition in the field probably accounts for its not having been discovered before. It has been found occasionally in considerable quantity on fallen leaves of diseased vines, and frequently appears on apparently healthy leaves from diseased vines which are kept in a sterile moist chamber for a week or two. It grows readily on various culture media and produces an abundance of ascogenous perithecia.

Ascogenous form.—The perithecia are ordinarily sparsely scattered over the under surface of the leaf, being buried beneath the epidermis, which is very slightly elevated and punctured by the short neck and ostiole (Pl. III, fig. 12). They usually vary in diameter from 300 to 400 μ. The short neck of the perithecium is beset with black, nonseptate spines 50 to 70 μ long by 8 to 9 μ thick at the base. These black spines are a constant and characteristic feature of the fungus, occurring in all of our cultures, as well as under natural conditions (Pl. III, fig. 13). On leaves the perithecia are somewhat depressed globose, but in artificial cultures, where there is no pressure from above as there is in the tissue of the host, they are somewhat pyriform. The wall of the perithecium is membranous or submembranous in texture and consists of a single layer of cells. The asci are clavate, short-stipitate, and range in size from 136 to 180 by 30 to 48 μ. They are accompanied by rather stout, sepate paraphyses, occasionally branched near the end and varying in dimensions from 200 to 340 by 5 to 8 μ. The ascospores are somewhat biseriate or irregularly uniseriate. They are hyaline until almost mature, but finally assume a pale yellowish brown color. In shape they are oblong elliptical, and the protoplasm is densely granular. They vary in size from 27 to 36 by 12 to 20 μ.

Fruiting specimens on leaves have been collected in May, July, August, September, and October, and have been found in Nova Scotia, Massachusetts, New Jersey, West Virginia, and Wisconsin.

No conidial or pycnidial form of this fungus has ever occurred in any of our numerous cultures, and no such form has been found associated with it in nature under such circumstances as to suggest a genetic relation.

Appressoria.—A rather remarkable body is produced by the germ tube of the germinating spore. This is a more or less disciform, dark-colored, rather opaque organ, with an irregular, rather deeply

lobed margin (Pl. III, fig. 17). It has been found upon the surface of leaves which bore mature perithecia, but was first found on the smooth surface of the upper portion of culture flasks where spores of the fungus had germinated. It is produced at the end of a short germ tube, arising from the ascospore, and its primary function is evidently that of an apressorium or holdfast.

Appressoria were first described and so named by Fisch [37] in 1882, as found in Polystigma. A little later Frank [38] described the same thing and also the similar productions occurring in *Gloeosporium lindemuthianum*. These bodies have usually been called chlamydospores. Meyer,[39] De Bary,[40] Büsgen,[41] and, more recently, Hasselbring,[42] have discussed these organs and their formation and function. Their production has generally been regarded as due to chemical or contact stimuli and lack of nutriment. The organs which are produced by *Acanthorhynchus vaccinii* differ in form from any of those described by the authors just mentioned. They have been found, as already stated, on the sides of glass culture flasks and upon the surfaces of cranberry leaves. They are produced in a few hours from fresh spores discharged against and adhering to the cover of a petri dish. These appressoria when transferred to culture media soon germinate and produce an abundance of ascogenous perithecia. They have also germinated on the covers of petri dishes where they have formed. This would appear to indicate that they possess a reproductive function not depending necessarily upon their connection with the surface of the host plant. When produced upon the surface of a cranberry leaf, the small irregular projections about the margin of the disk appear to attach themselves firmly, apparently by dissolving and forming small shallow cavities in the surface of the epidermal wall. A germ tube arises near the center, or sometimes toward the margin of the appressorium, and penetrates the surface of the leaf, usually in the sections we have studied entering through a stoma (Pl. III, figs. 21, 22). Sometimes the germ tube does not appear to penetrate the leaf at once, but sends out several superficial brownish filaments upon the surface of the leaf, as shown in Plate III, figure 20. These appressoria have been frequently found upon fallen cranberry leaves during the summer. They are sufficiently large to be easily observed, and are so firmly attached to the leaves that they are not readily removed.

Relationship of the fungus.—Acanthorhynchus is evidently closely related to certain Sordariaceous fungi, especially such genera as Sordaria and Hypocopra. The perithecia and spores are somewhat similar, and the spores are forcibly discharged from the asci at maturity, as in those genera. In Acanthorhynchus the whole mass of eight spores is thrown in some cases as much as 10 centimeters or

more, and, being embedded in a gelatinous matrix, they adhere to any object with which they come in contact. As the spores mature the protoplasm surrounding them becomes denser and forms a sort of secondary membrane (Pl. III, fig. 14, *c*). The ascus has a characteristic apex which suggests that of Hypocopra, as described by Zopf [43] and also by Griffiths,[44] though in Acanthorhynchus it does not turn blue upon the application of iodin and does not show the peculiar thickenings observed by Zopf. The mass of protoplasm surrounding the spores reaches to the apex of the ascus and is attached there. In the case of some asci from which the spores have been discharged a small caplike portion remains, which suggests that the ascus may rupture about the apex. In other cases, however, the spores seem to have been discharged through the apical pore or the ascus has been split longitudinally from the apical pore. It has been impossible to differentiate or to positively distinguish a secondary membrane about the mass of gelatinous protoplasm in which the spores are embedded, but the manner in which it holds together would signify that there may be an outer layer functioning as a secondary membrane.

Cultures of the fungus.—Cultures of this fungus were first obtained from mycelium found in the interior of rotten berries. These cultures were made by transplanting the mycelium as described in the case of *Guignardia vaccinii*. Perfect perithecia and asci have been produced in forty different cultures made from diseased berries. In a number of instances a mycelium apparently identical with that of Acanthorhynchus has appeared, but no perithecia were ever formed. The fungus grows and reproduces most readily on corn meal, corn meal agar, and cranberry agar and corn meal. A few mature perithecia have been formed on steamed sweet potato cylinders. The fresh ascospores sometimes germinate quickly in moist air and produce appressoria in a few hours. In most cases in which spores have been observed to germinate, appressoria have been formed. The spores very rarely germinate in culture media. They germinate in damp air or water on glass and also on cranberry leaves. In pure cultures the fungus first forms a branched white mycelium, which spreads concentrically from the point of origin, forming a rather close white layer, which continues to spread until the whole surface of the culture medium is covered. Soon the mycelium begins to assume a dirty, ochraceous color, which becomes quite uniform and is soon followed by the appearance of the dark perithecia of the fungus. These, when full grown, give a dark cast to the surface as they become uniformly distributed throughout the yellowish layer. As in case of other ascogenous forms whose natural mode of growth is within the tissues of their host, the perithecia in cultures are more or less covered with fungous hyphæ, with

the exception of the short neck, which protrudes above the surface of the mycelial subiculum (Pl. III, fig. 13). The fungus grows best at ordinary laboratory temperatures, varying from 20° to 26° C., and the mature perithecia are produced in from fourteen to thirty days. As in the case of Guignardia, and for the same reasons, we have been unable to determine yet at what time infection of fruit and vines takes place. Appressoria have not been observed on diseased berries, but, as already stated, they have been found on leaves, with the germ tube penetrating the tissue. The fungus is found in a fruiting condition on the cranberry bogs soon after the water is removed from the vines in the spring. It is therefore probable that infection of the young leaves begins about this time.

This fungus also evidently has the power of remaining in a dormant or inactive condition in the leaves and fruits, as is shown by the development of the fungus in apparently normal and healthy leaves and fruits which have been disinfected and kept in moist chambers in the laboratory. That the original infection is from external sources is shown by the presence of appressoria on the leaves, the germ tubes of which have been found entering the tissue (Pl. III, fig. 22).

TREATMENT.

What has been said in regard to the treatment of cranberry scald applies equally well to the rot. The two diseases almost always occur together, and Bordeaux mixture applied in the same manner as for scald has given satisfactory results.

ANTHRACNOSE.

Anthracnose is a disease not heretofore reported as affecting the cranberry. As is the case in most other diseases to which this name is applied, it is due to one of the fungi which have been called Gloeosporium. The ascogenous stage of the fungus having been produced, it is found to belong to the genus Glomerella and has been named *Glomerella rufomaculans vaccinii* Shear.[24] Like the scald and rot, this disease is at all times difficult, and usually impossible, to diagnose by a macroscopic examination of the diseased berries. The berries from which we have isolated the fungus which causes this disease have not been uniform in appearance. In one case the berry was very soft and light colored, while in other cases the fungus did not seem to have developed so rapidly and the portion of the fruit affected by the disease was not so soft. Acervuli sometimes develop on the diseased berry, but usually they do not. Judging from the infrequency of occurrence of this fungus in cultures made from affected berries, the disease is much less injurious than the rot or

scald. It appears, however, to be widely and generally distributed throughout the cranberry growing regions of the eastern United States.

THE FUNGUS (GLOMERELLA RUFOMACULANS VACCINII, SHEAR) CAUSING ANTHRACNOSE.

Two species of Gloeosporium have already been described as occurring upon species of Vaccinium, but their relation to the fungus causing this disease is doubtful. This parasite has been grown in pure cultures, producing both the conidial and ascogenous forms.

Conidial form.—The acervuli are rather small, scattered over the under or upper surface of the leaf and sometimes occurring upon old berries which have been destroyed by the fungus. The epidermis is usually somewhat dark colored immediately above and about the mass of conidia. At maturity the epidermis ruptures and the conidia form a light, flesh-colored, waxy mass upon the surface. They are hyaline or subhyaline, as observed under the microscope, and oblong elliptical, or sometimes slightly smaller at one end, varying in dimensions from 12 to 18 by 4.5 to 6 μ (Pl. III, fig. 2). The conidiophores are simple, tapering upward, and from 15 to 20 μ long. The conidia germinate readily in water or ordinary culture media. The mode of germination and growth agrees with that of other species of Gloeosporium, as described by Stoneman,[45] Clinton,[46] and others, except that no septum is formed in the conidia so far as observed. This conidial form has been found on berries from several localities in Massachusetts, and also on leaves from New Jersey which were soaked in corrosive sublimate 1–1,000 and kept in a moist chamber for from one to two weeks. It has also been obtained in cultures made from diseased fruit from Wisconsin, Massachusetts, and New Jersey.

Ascogenous form.—This stage of the fungus has not been found on the cranberry plant either in the field or in moist chambers, but has been grown in cultures from leaves bearing the fungus, and also from ascospores. The perithecia are membranous, subglobose or slightly pear shaped, usually somewhat buried in a felty subiculum or pseudo-stroma when growing on corn meal and forming a continuous layer over its surface (Pl. III, fig. 6). In old cultures they frequently become closely packed and form a more or less opaque stratum. The asci are clavate, sessile, or short stipitate, and measure 60 to 72 by 10 to 12 μ (Pl. III, fig. 7, *a*, *b*, *c*), and are sometimes accompanied by what seem to be evanescent paraphyses (Pl. III, fig. 9). The ascospores are somewhat irregularly biseriate, oblong elliptical, and occasionally slightly inequilateral or curved. They are hyaline

at first, but when fully mature become pale greenish yellow. They vary in size from 9 to 18 by 5 to 7.5 μ (Pl. III, fig. 8).

Appressoria, or chlamydospores.—In badly decayed berries and in old pure cultures the irregular dark-colored bodies have been found which have been called chlamydospores by some authors and appressoria by others (Pl. III, figs. 4 and 5). The work of Fisch,[37] Frank,[38] Hasselbring,[42] and others seems to show that the primary function of these organs is that of an appressorium. In the case of the cranberry anthracnose, at least, they may also function as reproductive bodies. Some of those found in the interior of a decayed berry (Pl. III, fig. 4) were carefully transferred to culture media and were found to germinate and produce a luxuriant growth of mycelium and conidia. It has been urged that they show no provision for distribution, as spores or reproductive bodies should. When produced in the interior of berries, however, they appear to show even less possibility of functioning as appressoria. The bodies as found in fruit and old cultures are somewhat variable in form and appearance, but agree in general with those produced upon the germ tubes arising from conidia. The light-colored spot frequently observed and regarded by some as a germ pore is quite as frequently wanting in the cases we have observed. Though probably primarily functioning as appressoria, these bodies under certain conditions appear to serve the purpose of a resting spore or chlamydospore.

Cultures of Glomerella rufomaculans vaccinii.—Cultures made from berries affected with anthracnose and from leaves have in most cases produced conidia only, but in four instances the ascogenous stage was also produced. The berries were from Massachusetts, New Jersey, and Wisconsin.

Cultures have also been made from leaves containing mycelium as well as from conidia and ascospores. The growth in all cases is essentially the same in appearance. The conidia germinate readily, sending forth one or more germ tubes, which soon begin to branch and then form a rather dense pure white mycelium. This on sterilized corn meal spreads rapidly until the surface of the medium is covered with a compact layer of the fungus. On poured plates of beef agar the growth of the mycelium is much less luxuriant. Acervuli of conidia begin to appear in three or four days, and these are frequently followed by the formation of dark-colored bodies resembling the fundaments of perithecia. These bodies, however, have never produced mature asci on agar cultures.

The germination of the ascospores and the subsequent growth and development of the mycelium are essentially the same as in the case of the conidia. Cultures from ascospores on poured plates of beef agar only produced conidia and what appeared to be young perithe-

cia, but no asci were ever found. Transfers made of germinating ascospores from such poured plates to flasks of sterilized corn meal produced ascogenous perithecia in abundance in about ten to twelve days. In the case of one culture made from a diseased berry, very few conidia were ever formed, but an abundance of the ascogenous form was present after eighteen days. We have not as yet succeeded in growing the ascogenous form in pure cultures from single conidia. Little opportunity, however, has been given for making such cultures from the ascus-bearing form, on account of the few conidia produced by it. Besides beef agar and corn meal, the fungus has been grown upon cranberry agar and corn meal, and also upon potato cylinders. Although the fungus appears to grow best on corn meal or cranberry agar and corn meal, there is nothing to indicate that the culture medium is the determining factor in the production of the ascogenous stage of the fungus. As in the case of the scald fungus, *Guignardia vaccinii*, the important factor seems to be some particular potentiality of the mycelium or spore from which the culture is made.

Factors determining the production of the ascogenous fructification.—Previous successful attempts of the writer and others to produce asci in various forms of Gloeosporium have indicated that there is a much more important factor involved than the culture medium or conditions of light, temperature, and moisture. Whether the nearness or remoteness of origin of the conidia from an ascogenous form is of importance has not yet been satisfactorily determined. The successful cultures made by Miss Stoneman [45] were from conidia taken from acervuli produced upon the different hosts of the species studied. In such cases, of course, there is no means of determining the ancestry of the conidia used.

Relationship of the fungus.—The ascogenous forms of the numerous anthracnoses known have very rarely been recognized or reported as occurring under natural conditions. It is probable, however, that some of the pyrenomycetous fungi which have been described under the genera Physalospora or Phomatospora, or perhaps under other closely related genera, are really the ascogenous forms of species of Gloeosporium. The very close relationship of many of the species described under these genera and the want of any very striking or peculiar characteristics of the known ascogenous forms of Gloeosporium make it difficult to determine with certainty from purely morphological characters the generic identity of these organisms. The name Glomerella has been proposed for these fungi by Spaulding and von Schrenk.[47] This name, however, may have to be abandoned if it can be demonstrated that ascogenous forms heretofore described under an older valid generic name are really stages in the development of congeneric species. The question of specific distinctions in

this genus is very perplexing. The differences in the morphological characters of the ascogenous fructifications are quite as slight and unsatisfactory for separating species as the differences which occur in the conidial forms. This has been clearly shown by the studies of Shear and Woods.[35] Various inoculation experiments made with the conidial forms occurring on different hosts have seemed to indicate that they will pass readily from one host to another. Most such inoculation experiments appear to us inconclusive, particularly in such cases as those given by Halsted [14] and others, in which transfers of conidia were made from one mature fruit to another by inserting the conidia in the fruit. These experiments may perhaps be more correctly interpreted as indicating that the fruit upon which the fungus grows successfully in such an inoculation experiment is simply a satisfactory nutrient medium for the fungus. In order to demonstrate the possibility of the various forms being passed from one host to another as actual parasites, it would be necessary to make the inoculations on the living and actively growing parts of the plants. This has been done in one case, at least, by Sheldon,[48] in which he successfully inoculated stems and leaves of growing sweet peas by applying conidia from the bitter-rot (*Glomerella rufomaculans* (Berk.) Spauld. & von Schrenk) of the apple. Whether other forms will show equal ability to pass from one host to another as active parasites remains to be determined.

Dormant condition of the fungus.—We have found by experiments similar to those described in connection with the account of the scald fungus, *Guignardia vaccinii* (p. 21), that the mycelium of the cranberry Glomerella may remain in an inactive or dormant condition in the tissues of the living fruit of the cranberry for a considerable time. Whether the fungus is really inactive or not it is difficult to say. It at least does not give the slightest local external evidence of its presence. Berries which were, so far as could be determined by external examination, perfectly sound and free from fungi, were very thoroughly soaked and washed in a 1–500 solution of corrosive sublimate. Such leaves and berries when placed in warm, sterile, moist chambers developed typical cases of anthracnose. On the leaves treated in the same manner numerous acervuli have appeared, and cultures made from the mycelium found in the decayed fruits mentioned above have produced the conidia in pure cultures. Inoculation experiments, made by applying fresh conidia to the surface of cranberries and apples placed in warm moist chambers, have been without definite results. It seems that in the case of this fungus, as well as Acanthorhynchus and Guignardia, the spores do not possess the power of penetrating the epidermis of the fruit after it has reached maturity. Infection apparently occurs earlier in the season,

but the exact time and manner has not yet been determined for want of plants known to be entirely free from disease.

TREATMENT.

From the beneficial results of spraying cranberries where this disease was known to be present and also from the success obtained in preventing other diseases caused by similar fungi, such as the bitter-rot fungus of the apple,[49] it appears probable that thorough spraying with Bordeaux mixture will prove a satisfactory treatment. The disease so far as now known is always associated with scald or rot, and the treatment recommended for those diseases will be sufficient for this.

HYPERTROPHY.

The fungus (*Exobasidium oxycocci* Rostr.) causing hypertrophy is only known at present from Massachusetts. In 1906 it destroyed a considerable part of the crop on several cranberry meadows in that State and caused considerable alarm. It is apparently somewhat erratic in its behavior. On one meadow it attacked almost every plant on a part of the bog, while some other portions were almost free from it. The variety known as Matthews seemed to be especially susceptible to the disease.

The disease first makes its appearance on flooded bogs soon after the water has been removed in the spring, which is usually about the middle of May or a little later. The axillary leaf buds, which usually remain dormant, are attacked by the disease and produce short shoots with rather close, enlarged, swollen, and distorted leaves which are pink or light rose colored (Pl. VII, *C* and *D*). The colored hypertrophied leaves, being close together, bear a slight superficial resemblance to a flower of some sort. This appearance has led some persons to call these diseased shoots "false blossoms." This is misleading, as it suggests some reference to the flowers of the cranberry, which are not included in this peculiar malformation.

Most of the affected plants are attacked before the blossoms have developed, thus preventing the production of fruit. Shoots whose buds are attacked later in the season after the blossoms have opened or fallen (Pl. VII, *D*) also usually fail to develop fruit, as the vitality of the shoot is apparently exhausted by the fungus. Besides the fruit-bearing shoots, ordinary vegetative shoots or runners are also affected in the same manner (Pl. VII, *C*).

No opportunity has been afforded to examine plants which had suffered from this disease the previous year, but the injury to the affected plants and the lowering of their vitality are so evident that the production of fruit the succeeding season would probably be far below normal even though the disease did not recur upon the plants.

THE FUNGUS (EXOBASIDIUM OXYCOCCI, ROSTR.) CAUSING HYPERTROPHY.

In this, like all Exobasidii, the mycelium of the fungus infests the tissue of the leaves and stems, producing the hypertrophied condition described above. The basidia are elongate clavate, and are produced at the extremities of the hyphæ. They emerge on the surface of the affected part of the host and produce usually four basidiospores at the ends of short, slender sterigmata. The spores are usually somewhat fusiform, slightly curved, and hyaline, measuring 14 by 3.5 μ. They proceed to grow soon after falling and may be seen in old specimens in different stages of germination. From one to three transverse septa are usually formed, after which a germ tube arises from either or both ends, which produces conidia somewhat resembling the basidiospores, but smaller. The fungus, when mature, gives a fine, gray, powdery appearance to the surface of the distorted parts of the host.

Relationship to other Exobasidii.—This species, so far as it has been studied, agrees in morphological characters with *Exobasidium vaccinii* (Fckl.) Wor. The spores of *Exobasidium vaccinii* are, according to Saccardo, 5 to 8 by 1 to 2 μ. This, according to Woronin,[9] Richards,[59] and others, is an error, as the basidiospores usually range from 14 to 17 by 3 μ. The error possibly arose from the confusion of basidiospores with conidia, which are frequently present, especially in specimens which are getting old.

The typical form of *Exobasidium vaccinii* occurs on *Vaccinium vitis-idaea*, producing hypertrophied spots on the leaves. No record has been found of the occurrence of hypertrophied shoots on this host similar to those found on cranberry plants. Rostrup[51] seems to have been the first to describe this form. In 1883 he reported it as occurring on *Oxycoccus palustris* in Denmark. His description accords exactly with the specimens we have found on the cranberry plant. He says he could not find the two forms, i. e., the one producing spots on the leaves, typical *Exobasidium vaccinii*, and the one producing hypertrophied shoots, *Exobasidium oxycocci*, on the same plant, but the two were found in the same locality in one instance.

An Exobasidium also occurs on cranberry plants in Massachusetts, which produces spots on the leaves like those produced on *Vaccinium vitis-idaea*, and agrees also in all microscopical characters with *Exobasidium vaccinii* (Fckl.) Wor. (Pl. VII, *A* and *B*). No specimens of the two forms could be found on the same plant or in the same vicinity. No cross-infection experiments with these two forms have been tried on these hosts so far as known, and as the observations already made seem to indicate the probability of their

being separate species, we shall retain for the present the two names as already used.

Richards[59] reports infection experiments with the Exobasidium producing spots on leaves of Andromeda and the one forming large inflated galls on the same host. He succeeded in producing the leaf-spot form by using spores from the gall-producing form which was named *Exobasidium andromedae* by Peck.[53] This suggests the possibility of the interchange of other forms, and it is hoped that further work may be done in this direction.

Exobasidium oxycocci occurs in greatest abundance in May and June. It has also been collected as late as September, when occasional fresh specimens were found at Brewster and Pleasant Lake, Mass.

TREATMENT.

Little, if anything, so far as can be learned, has been attempted in the way of controlling diseases caused by Exobasidii, as they have rarely assumed economic importance. As definite knowledge in regard to time and manner of infection is lacking, it is difficult to recommend treatment. It is possible that spraying with Bordeaux mixture may be beneficial, and experiments in this direction are planned for the coming season, when it is also hoped to secure more knowledge of this fungus.

LESS IMPORTANT DISEASES.

FUNGI ATTACKING THE FRUIT.

Synchytrium vaccinii Thomas.—This fungus was first described from New Jersey specimens by Dr. Fr. Thomas,[55] of Germany, in March, 1889, under the above name. When first discovered it threatened to do serious injury to the New Jersey cranberry bogs. It was first found in 1886 upon a bog near Browns Mills, N. J. Doctor Halsted,[10] of the New Jersey Experiment Station, gave an account of the disease in 1889, and called the parasite the cranberry gall fungus. The fungus attacks the leaves and young stems as well as the flowers and fruit, forming great numbers of small, reddish, gall-like swellings upon their surface (Pl. IV, figs. 15 and 16). Sections of these galls show the fructification of the fungus embedded near their center (Pl. IV, fig. 17). The fungus consists of a scanty vegetative mycelium producing globose sporangia, which finally develop a mass of swarm spores within. The sporangia rupture and the spores are then set free. These swarm spores are motile and well adapted to distribution through the water. At the time this fungus was found at the place mentioned a considerable portion of the plants on one side of the cranberry meadow was affected and the

complete destruction of the vines was threatened. So far as known the only measure taken to prevent the disease was the withholding of the water during the winter, as it was believed that the disease was distributed chiefly by the water. This plan seems to have proved successful, as the disease disappeared entirely within a few years. When the affected bog was recently visited it was impossible to find a trace of the fungus present on the vines or to learn of its occurrence anywhere in the region since. It seems to have entirely disappeared.[a] Similar sudden appearances of new parasites have been observed. No entirely satisfactory explanation of such phenomena has yet been given. Their sudden disappearance is less common. This fungus is not restricted to the cranberry plant, but has been found on several other ericaceous plants. Specimens on the following hosts collected by Doctor Halsted in New Jersey are preserved in the pathological collections of the Department: *Gaultheria procumbens*, *Cassandra calyculata*, *Kalmia angustifolia*, *Azalea viscosa*, *Clethra alnifolia*, and *Gaylussacia* sp. It may be expected to appear again if the conditions for its development and spread should happen to be favorable. Since its discovery in New Jersey it has been found as far north as Newfoundland, but has not been reported as doing harm to the cranberry, except in the case mentioned.

Pestalozzia guepini vaccinii Shear.[22]—This fungus has been isolated in eight instances from diseased cranberries. It is also frequently found on the leaves of the cranberry plant. The effect of this fungus upon the berries, like that of some other parasites, is not sufficiently characteristic to enable one to recognize it by an examination of the fruit. Hence we are unable to determine how much injury is caused by it. The indications are, however, that it does not do nearly as much damage as the other parasites already described. It is much more frequent upon the leaves than upon the berries and may be found upon the recently fallen leaves during the summer. It also develops very frequently on leaves apparently free from disease when they are placed in a sterile moist chamber.

The acervuli of the fungus are formed beneath the epidermis and are sparsely scattered over the leaf (Pl. II, fig. 15). As the fungus matures the epidermis ruptures and the spores collect in dark masses or spread out and form a thin layer upon the surface about the acervuli. The conidia are elliptical and somewhat inequilateral and usually four-septate (Pl. II, fig. 15, *a*, *b*). The three central cells are dark colored and usually guttulate. The septum below the upper cell is usually darker than the others. The two terminal cells are hyaline, and the apical one is furnished with three to four filiform setæ,

[a] Since this was written the disease has again been reported as occurring this season in New Jersey.

varying from 22 to 35 μ in length. The basal cell also has a short hyaline appendage 6 to 12 μ long.

This fungus is quite generally distributed in the cranberry-growing regions. Specimens have been obtained from West Virginia, New Jersey, Wisconsin, Massachusetts, and New York.

Pestalozzia guepini Desm. is given by Farlow and Seymour[60] as occurring on the cranberry, but a study of that species indicates that our plant is a variety at least, as indicated, and may perhaps be found to be a distinct species.

The spores of this fungus germinate readily under ordinary laboratory conditions in water or culture media. The germ tube almost invariably arises from the basal cell of the spore (Pl. II, fig. 15, *c*, *d*). Occasionally two germ tubes arise, one from each side of the basal cell (Pl. II, fig. 15, *d*). The germ tube grows rapidly and soon begins to branch, forming a nearly white mycelium. This covers the culture medium with a thin, rather compact layer. About the time acervuli begin to form, a faint pinkish tinge appears. Acervuli and spores are produced in about ten to twelve days. The acervuli first appear as dark-colored dots. Spores are produced in enormous numbers and spread about the acervuli in irregular black masses.

This fungus has been grown from leaves and fruit from different sources on different media and under different conditions for several years, but no other spore form has ever been found. Where the growth of the fungus is very luxuriant, abnormal spores are produced, which bear four or five and rarely six appendages, sometimes much longer than usual, and branched.

This fungus is common and widely distributed, but so far as our knowledge goes does not attack the fruit with sufficient frequency to cause much loss. It is much more common on the foliage and may thus injure the plants affected. It has been found to be present in leaves which showed no external signs of disease, as has already been noted in the case of *Guignardia vaccinii* and some of the other cranberry fungi.

There is reason to believe that where the disease is present it can be controlled by the usual treatment with Bordeaux mixture.

Helminthosporium inaequalis Shear[24].—This fungus has been obtained in cultures made from diseased cranberries from New Jersey. These cultures were made November 8, 1905, by carefully transferring the fungous hyphæ from the pulp of affected berries to flasks containing sterilized corn meal. There was nothing in the external appearance of these berries to indicate that the injury was due to other than the usual rot or scald fungi. The first growth of the mycelium was nearly white, but very soon assumed a light, smoky color, and finally became a dark, smoky brown. The whole surface

of the medium was covered with a thick, loose layer of much-branched hyphæ. The vegetative hyphæ frequently form strands of several filaments closely united (Pl. V, fig. 8).

The fertile hyphæ were distributed over the surface and bore conidia at the apex as well as at the sides (Pl. V, fig. 4). These conidia are somewhat elliptical and usually conspicuously inequilateral (Pl. V, figs. 5, 6, 7). They are thick walled and from three to five celled at maturity, all but the terminal cells, which are hyaline, being of a deep-brown color. The conidia measure from 18 to 36 by 8 to 14 μ. In old cultures tufts or clusters of erect, slender, irregular, somewhat branched, hard, black bodies 5 to 15 millimeters in length are formed in great abundance, covering the surface of the culture (Pl. V, fig. 9). These appear to be of a sclerotoid nature. They have never been found to bear fructifications of any sort. When broken up and pieces are transferred to culture media, the mycelium grows and soon produces conidia. So far as known this fungus is of infrequent occurrence and probably causes very little injury. It has not been found in a fruiting condition upon fruit or vines in the field.

Gloeosporium minus Shear.[24]—Besides the Gloeosporium (*Glomerella rufomaculans vaccinii*), already described as causing the cranberry anthracnose, another has been found which has been published under the above name. Only the conidial stage is known. All efforts to produce an ascogenous form have thus far failed.

The acervuli are amphigenous, small, and scattered, and do not form a definite discolored spot on the leaf so far as observed. They sometimes occur upon the berries. In such cases the epidermis is dark colored above and about the acervulus. The conidia are discharged through a rupture in the epidermis and form a pale pinkish, glutinous mass. They are oblong-elliptical or subcylindric and sometimes inequilateral or somewhat clavate (Pl. III, fig. 11), and are usually guttulate when fresh. They vary in size from 6 to 9 by 3 to 4 μ and are borne on simple, slightly tapering sporophores one and a half to two times the length of the conidia. No setæ have been observed in any of the acervuli.

The conidia of this species are only about one-half as large as those of *Glomerella rufomaculans vaccinii* and show no great amount of variation, either under natural conditions or in cultures. This species is perhaps closely related to *Gloeosporium myrtilli* Allesch., which has conidia 6 to 10 by 1.5 to 3 μ, and occurs on *Vaccinium myrtillum* in Germany.

This fungus was first found on cranberries offered for sale in the Washington market in April, 1902. It has also been found on cranberry leaves from New Jersey and has been isolated from other leaves from the same State. It is apparently of comparatively rare occurrence and perhaps of little importance as a disease producer.

Sporonema oxycocci Shear.[24]—This excipulaceous fungus has been found on cranberry leaves from various localities. The pycnidia are imperfectly developed, the upper portion being thin and disappearing toward the center of the disk (Pl. V, fig. 18). They are dark brown, scattered or gregarious, pulvinate, covered by the epidermis, and measure about 50 to 100 μ in diameter. They rupture by a longitudinal or irregularly triangular slit (Pl. V, fig. 17). The spores are continuous, hyaline, cylindrical, obtuse, borne on very short ovoid sporophores, and measure 17 to 19 by 3 to 4 μ (Pl. V, figs. 19 and 20). In cultures the range of variation in spore measurement was somewhat greater, being 15 to 20 by 3 to 4 μ.

Specimens have been obtained from Carver and on Cape Cod, Mass., and Martinsville, Me.; also from near Belleplain and Whitesville, N. J., the dates ranging from June to September.

This fungus has usually been found on dead or dying cranberry leaves, but in one instance it was found in a diseased berry which was obtained in the Washington market. The berry had a soft, slightly discolored spot. After thoroughly washing and soaking the berry in corrosive sublimate solution, a portion of the diseased pulp and skin of the fruit was carefully transferred to a flask of sterilized corn meal. Normal pycnidia of the fungus developed upon the portion of the skin of the berry in the culture. The mycelium spread to the culture medium and formed a rather compact thin layer, at first whitish, then dark grayish green, and finally dark grayish brown and somewhat mouse colored. In about a month mature pycnidia were formed about the sides of the flask. The so-called pycnidia are incomplete and consist in the culture of dense, dark, pulvinate masses depressed at the center where the pycnospores are borne and somewhat overgrown by loose hyphæ from about the margin. Frequently instead of normal spore development the sporophores became lengthened and formed irregular stout hyaline filaments about twice the length of the spore. The single instance in which this fungus has been found in the fruit shows that while it is capable of injuring the fruit, it perhaps does very little damage at present.

Arachniotus trachyspermus Shear.[25]—This fungus was first isolated from a very badly diseased berry from New Jersey which had been kept from September until April 11. The berry was very soft and light colored. The same fungus has also occurred twice on the surface of decayed fruit which had been kept in a moist chamber for a considerable period.

In pure cultures the fungus first forms a fine, thin, white mycelium, which is soon followed by the development of minute arachnoid snowy-white perithecia (Pl. IV, figs. 18 and 19), which are 325 to

425 μ in diameter and consist of slender, thin-walled, unarmed hyphæ, forming an anastomosing arachnoid layer about the mass of asci. The asci are globose or subglobose, very thin walled, and 7 to 8 μ in diameter (Pl. IV, figs. 20 and 21). The ascospores are ovoid, light lemon yellow in mass, echinulate-roughened, and measure from 3.25 to 4 by 2 to 2.5 μ (Pl. IV, fig. 22). The asci are very closely packed together and borne upon the tips of the very slender and scantily branched filaments of the ascogenous hyphæ. It is not until the ascospores are fully mature that the color and rough surface are readily recognized.

The species is closely related to *A. candidus* (Eid.) Schroet., but differs in having rough, faintly colored spores. A minute, greenish, conidial form resembling Penicillium occurred in all the old cultures of this fungus. These cultures were apparently pure and free from contamination, and it seems quite probable that this represents the conidial stage of this Arachniotus. We have, however, been unable as yet to satisfactorily demonstrate this by other cultures made from ascospores and conidia. This fungus has not been found fruiting in the field, and is probably of no great pathological importance.

Septoria longispora Shear.[24]—This fungus has been collected three times in New Jersey—twice upon cranberry leaves and once upon a fruit. It has also been grown in ten cases in cultures from cranberry leaves. The pycnidia are scattered over the surface of the leaf or fruit and seated beneath the epidermis. They vary in size from 120 to 250 μ in diameter (Pl. IV, figs. 12 and 13). No definite spot or discolored area seems to be formed. The pycnospores are very long and slender and curved, varying from 150 to 240 μ by 3 to 4 μ (Pl. IV, fig. 14). When straightened they reach 300 μ long. They are borne on simple slender sporophores 6 to 9 μ long. The length of the spores seems to separate this species from any other Septoria described, as they are twice as long as those of any species heretofore known. This fungus appears to attack the fruit but rarely. It has been found only in New Jersey, and is apparently of infrequent occurrence.

Sphaeronema pomorum Shear.[24]—This fungus has been found but once. It was obtained in a culture made by the transfer of hyphæ from the interior of a diseased berry taken from a lot of sprayed fruit from New Jersey. It has been kept growing on culture media for a long time. The fungus first formed a thin white layer upon the culture medium, and this was soon followed by the development of numerous pycnidia quite evenly scattered over the surface of the mycelial layer, giving it a dark appearance. The pycnidia are membranous or subcoriaceous, globose or subglobose, 120 to 200 μ in diameter, and provided with a slender neck about 80 μ long (Pl. V, fig. 1). The pycnospores are hyaline or pale greenish yellow in

mass, oblong or subcylindric, and measure from 5 to 10 by 3 to 6 μ (Pl. V, fig. 1, *a*). This fungus has not been found upon either leaves or fruit in the field, and appears to be of rather rare occurrence.

Phyllosticta putrefaciens Shear.[24]—This fungus has been obtained in two cases in cultures made from the hyphæ taken from the interior of decayed berries. The berries were picked from the sprayed plats at Whitesville, N. J., and kept in the laboratory about a month. The berries showed no external appearances which would indicate that the disease was different from that produced by rot or scald fungi.

The pycnidia are gregarious, membranous, globose, or subglobose, and vary from 75 to 150 μ in diameter (Pl. V, fig. 10). The spores are faintly yellowish in mass, ovoid or oblong-ovoid, and measure from 4 to 6 by 2 to 3 μ (Pl. V, fig. 10, *a*). In the cultures the fungus first produced a thin, white, floccose mycelial layer over the surface of the medium. This gradually became thicker and then produced a layer of black pycnidia. What appears to be the same fungus has been found on leaves from Massachusetts. A fungus closely resembling this one has also been collected in Massachusetts on cranberries which had been destroyed by the berry worm. The spores were slightly larger and the ostiole different. This fungus presumably is the pycnidial stage of some ascogenous fungus, but no such form has appeared in any of the numerous cultures which have been made.

Anthostomella destruens Shear.[24]—This fungus has only been found in one instance, when it was obtained from a diseased berry grown in New Jersey. The culture was made November 2 by transferring the fungous hyphæ from the interior of the berry, as in the other cases mentioned. A white mycelial layer was first formed, and this was soon followed by the development of black perithecia more or less overgrown by the white filaments of the mycelium. The perithecia are membranous or submembranous, globose, and 350 to 450 μ in diameter (Pl. IV, fig. 8). The asci are cylindric or cylindric-clavate and vary from 150 to 225 by 14 to 18 μ (Pl. IV, fig. 9). No paraphyses have been found. The ascospores are dark brown, elliptic, uniseriate, and 16 to 24 by 10.5 to 12 μ (Pl. IV, fig. 10). This fungus has not been found fruiting in the field and is apparently of rare occurrence. None of the cultures made from ascospores has shown any other spore form. The plant is perhaps rather closely related to *Anthostomella picacea* (C. & E.) Sacc., which has been found on Vaccinium, but it is easily separated by the size of the asci and spores.

Penicillium glaucum Link.—This fungus occurs frequently on old diseased fruit when it is kept in a sterile moist chamber. It grows especially upon the old calyx of the flower and the apex of the fruit and has been isolated from the pulp of decayed fruit. In cultures and

on decaying fruit it occasionally produces the coremium form. The fungus probably does not cause decay of the fruit, except where the skin has been injured to permit its entrance.

Leptothyrium pomi (Mont.) Sacc.?—Occasionally about picking time there appear on cranberries minute black fungous specks or spots having an appearance identical with that of the "flyspeck" or fruit speck of the apple. Microscopical examination shows that these spots consist of thin, dense, superficial, dark-colored, short-celled, rather thick-walled hyphæ. When old the spots are slightly convex, and when examined in cross section show a somewhat lighter colored compact cellular mass closely attached to the epidermis of the fruit (Pl. V, fig. 15). Specimens kept for a long time in a moist chamber have never shown any indication of spore formation. A study of these specks in different stages of formation shows that they arise from a germinating spore. An anastomosing, dark-colored, thick-walled mycelium is formed (Pl. V, figs. 13 and 14), which continues for some time to increase in size and thickness until it reaches the condition shown in Plate V, figure 15. A careful examination of the surface of berries bearing these specks revealed the presence of three different kinds of fungous spores (Pl. V, fig. 16, *a*, *b*, and *c*). Those shown at *b* and *c* were rather frequent. The form shown at *a* is the only one which was found germinating, and as remains of similar spores were found connected with the very young specks we are led to think that they are produced by these spores. We have no means of knowing to what genus of fungi any of these spores belong. Those shown at *c* bear a strong resemblance to Cladosporium.

So far as we have been able to learn, no one in this country has found any spores produced by this fungus. We have attempted to grow the plant in culture media, but without success. *Labrella pomi* Montagne[56] was described as follows: "Macula nulla, peritheciis ellipticis minimis rugosis nitidis, sporidiis globosis." In view of the mention of globose spores in the description and our scanty knowledge of the original plant, it is rather doubtful whether the plant we are dealing with is that described by Montagne.

This fungus has only been seen from one locality, Parkdale, N. J. It does not seem to injure the fruit except that it renders it unsightly. Thorough spraying will probably prevent its appearance.

FUNGI OCCURRING ON THE LEAVES OR STEMS.

Several of the species of fungi already described as attacking the fruit are also found on leaves or stems. The following species have been found only on the leaves or stems of the cranberry. So far as our present knowledge of these goes, they do not cause sufficient injury

to be of great economic importance. Their future behavior can not be foreseen, however, and they may bear some direct relation to each other or to the other parasites which may prove important.

Venturia compacta Peck.[54]—This fungus has been before reported upon the cranberry by Professor Peck, who found it in New York. It has also been collected, according to Ellis, in Maine, and by Halsted in northern New Jersey. We have found it on cranberry leaves from Nova Scotia, and also from Massachusetts, New Jersey, and Wisconsin. Fusicladium has been demonstrated to be the conidial stage of certain species of Venturia, but no such conidial form has been found in connection with this species. *Cladosporium oxycocci* Shear has been found associated with it, but nothing is known as to the relation between the two forms.

This fungus shows considerable variability, especially in the grouping of the perithecia and the production of spines, the size and shape of the asci, the presence or absence of paraphyses, and the arrangement of the spores. The perithecia are usually aggregated in rather dense clusters, but are occasionally solitary (Pl. IV, fig. 1). The spines may be few and arranged about the ostiole or more numerous and scattered over the upper half of the perithecium (Pl. IV, figs. 3 and 5). They vary in size from 30 to 60 by 6 μ. The asci are usually swollen at the lower end (Pl. IV, fig. 6), but are frequently cylindrical (Pl. IV, fig. 4). They vary in size from 48 to 66 by 9 to 12 μ. The spores are very constant in size and shape, measuring 14 to 18 by 4 to 6 μ. It was at first thought that the extreme forms might be separate species, but a study of more material shows all sorts of intermediate conditions. Schweinitz[57] has reported *Venturia cinnabata* Fr. on *Vaccinium macrocarpum* from Pennsylvania. An examination of Schweinitz's specimen indicates that it is *Venturia compacta* Pk. Fries's[58] species was found on *Vaccinium oxycoccus*, and so far as the description goes scarcely differs from our plant, except that the perithecia are said to be solitary. We have been unable to find a specimen of Fries's species in his herbarium, and it is perhaps doubtful whether the two species are the same. It seems rather probable, however, that such is the case.

This fungus seems to be comparatively rare except in Massachusetts, and though a parasite it evidently does little damage. It is not known to attack anything but the leaves. However, from the habits of its near relatives, which cause the serious scab diseases of other fruits, it may perhaps sometimes attack the fruit of the cranberry.

Sclerotinia oxycocci Wor?[59]—The Monilia form of a fungus closely resembling this was found upon the young leaves and tips of cranberry plants sent from Wisconsin in July, 1905. This fungus has

not been reported heretofore upon the American cranberry, though different species of the genus attack various species of Vaccinium in Europe and do considerable damage to the fruit. Under favorable conditions for its reproduction and distribution this fungus might prove a very serious enemy of the cranberry, and it is quite important that steps should be immediately taken to eradicate it whenever and wherever it is found.

The ascogenous stage of this fungus has not yet been found here, though it probably occurs in the locality from which the conidia were obtained. The conidia are borne in chains and measure 12 to 20 by 10 to 12 μ (Pl. IV, fig. 23). They agree in all particulars with Woronin's description and figures, except in the size of the spores. In his description Woronin gives 25 to 28 by 16 to 22 μ as the measurements.

Discosia artocreas (Tode) Fr.—This fungus has been found on cranberry leaves from Cranmoor, Wis., which had been kept in the laboratory in a moist chamber. Other specimens have been obtained on leaves from near Whitesville and Jamesburg, N. J., from Wareham and Brewster, Mass., and from West Virginia. The specimens collected in the field were found in September and November. This fungus has usually been regarded as a saprophyte and probably does no particular injury to the cranberry plant.

Plagiorhabdus oxycocci Shear.[24]—This interesting fungus, which it has been necessary to refer to a new genus and species, was found on cranberry leaves collected near Carver, Mass., in May, 1906. The pycnidia are scattered, slightly erumpent, covered by the epidermis, 125 to 190 μ in diameter. The wall is not regular and well developed, but is thicker and denser above. The interior is either simple or somewhat chambered, but opens through a single ostiole (Pl. V, fig. 2). The pycnospores are hyaline or faintly colored in mass, and are borne on slender, simple sporophores (Pl. V, fig. 3). They measure 8 to 11 by 3 μ and are borne obliquely on the sporophore, which is abstricted at its base and remains as an appendage (Pl. V, fig. 3, *a*), which is 10 to 15 by 0.75 μ. This species is closely related to *Plagiorhabdus crataegi* Shear,[24] which is found on the fruit of Crataegus. It would therefore not be surprising if the species occurring on the cranberry should also be found upon the fruit.

Sporonema pulvinatum Shear.[24]—This fungus has been found upon cranberry leaves in three instances—once on leaves collected in New Jersey in November, 1905, and once on leaves from Olympia, Wash., collected in October; also upon leaves from West Virginia collected in June and kept in a sterile moist chamber. The pycnidia are simple, dark brown, pulvinate, formed within the epidermis, the outer wall of which adheres to their surface. They are 300 to 420 μ

in diameter by 100 to 150 μ thick, and sometimes collapse from above (Pl. V, fig. 25). No signs of an ostiole have been seen, and the manner in which the pycnidium ruptures is not known. The spores are pale greenish yellow in mass, continuous, subelliptical, and somewhat curved, 6 to 8 by 2 to 2.5 μ. They are borne on simple, tapering sporophores about twice the length of the spores (Pl. V, figs. 27 and 28). The pycnidia bear a close resemblance to immature specimens of *Lophodermium melaleucum* (Fr.) De Not., and it may be the pycnidial stage of this or the closely related *Lophodermium oxycocci* (Fr.) Karst. This fungus is closely related to *Sporonema epiphyllum* (Fr.) Shear[24], but has larger pycnidia and smaller spores, which are less curved and without a pseudoseptum.

Rhabdospora oxycocci Shear.[24]—This fungus has been found on leaves still adhering to old cut vines collected in September and November near Whitesville, N. J. The pycnidia are formed beneath the epidermis on the under side of the leaf and are quite evenly distributed over its surface. They are depressed-globose, slightly erumpent, and somewhat cushion shaped, 150 to 225 μ in diameter. The wall consists of two layers, which sometimes separate, the inner collapsing and expelling the spores (Pl. V, figs. 21 and 22). The ostiole is plain or slightly depressed and the epidermis above the pycnidia is blackened and transformed by the fungus. The pycnospores are hyaline, narrow cylindric-fusiform, and slightly curved. They show one or two septa or pseudosepta at maturity and measure 20 to 26 by 2 to 3 μ. The sporophores are slender and branched (Pl. V, figs. 23 and 24). This fungus has not yet been found attacking the berries.

Leptothyrium oxycocci Shear.[24]—This fungus has been collected several times on living and dead leaves.[a] It was first sent from Pierceville, Mass., by Mr. H. J. Franklin, May 22, 1906. The pycnidia are dimidiate, scattered, irregular, black, erumpent, subsuperficial, collapsing and rupturing irregularly, or breaking free about the base, 160 to 250 μ in diameter (Pl. V, figs. 29 and 30). The wall of the pycnidium shows a more or less parallel series of cells in its structure (Pl. V, fig. 31). The spores are hyaline, fusiform-elliptic, uniseptate, 10 to 15 by 2.5 to 3 μ and borne on slender, tapering sporophores (Pl. V, figs. 32 and 33).

Ceuthospora (?) lunata Shear.[24]—This fungus has been collected several times on dead and dying cranberry leaves. It was first found by the writer near Wareham, Mass., in September, 1902. It has also been collected at Carver and Onset, Mass., and near Whitesville, N. J. The pycnidia are scattered, depressed-pulvinate, slightly erumpent,

[a] Since the above paragraph was written, this fungus has been found on old mummied fruit at the same place where the other specimens were collected.

200 to 375 μ in diameter, irregularly chambered within and bearing a single prominent ostiole, through which all the chambers empty (Pl. V, fig. 11). The walls are subcoriaceous and irregular in thickness. The sporogenous hyphæ form a dense, compact, intricate layer, the ultimate divisions of which are somewhat dichotomous and bear the short, elliptic, inequilateral, or slightly curved, simple, hyaline spores, which are 7 to 9 by 3 to 3.5 μ (Pl. V, figs. 12 and 12, *a*).

The generic relationship of this fungus is rather uncertain, and we have referred it for the present to Ceuthospora, though it does not well agree with the description of the genus.

Valsa delicatula C. & E.—This fungus has been collected at Whitesville, N. J., on old cranberry stems which had been piled at the edge of a bog. It also occurs on other ericaceous plants in New Jersey, but has not heretofore been reported upon the cranberry. Associated with the ascogenous perithecia on the same stems was found a Cytospora, which is perhaps the pycnidial condition of this species.

Cladosporium oxycocci Shear.[24]—There are occasionally found in the spring on leaves of the previous year small, brownish, diseased spots bearing a Cladosporium, to which the above name has been given. The fertile hyphæ are brown, septate, more or less flexuous, and erect or spreading. They vary from 50 to 100 μ in length and arise from a small, black, sclerotoid base (Pl. IV, fig. 24). The conidia are acrogenous, varying from ovoid to cylindric-clavate, pale yellowish brown, continuous or uniseptate, and 15 to 24 by 3 to 4 μ (Pl. IV, fig. 24, *a*). We have specimens from Arichat, Nova Scotia, from Cape Cod, Massachusetts, and from Belleplain, N. J.

Another Cladosporium which has not been identified specifically has also been found on dead tips of young shoots of the cranberry from Massachusetts.

Plectrothrix globosa Shear.—This fungus was described by the writer in 1902.[22] It occurred on cranberry leaves which were kept in a sterile moist chamber in the laboratory and was quite regularly associated with *Pestalozzia guepini vaccinii*, making its appearance soon after the maturity of that fungus. It probably has no genetic relation to Pestalozzia, however. The plant has not been collected in the field and is perhaps a simple saprophyte.

Chondrioderma simplex Schroet.—This myxomycetous fungus was found at Hampton, N. J., covering living cranberry vines and other plants. It apparently did no injury, however, except such as might be caused by temporarily covering the surface of the leaves and vines. The sporangia and spore masses soon rupture and disappear after maturity and are not likely to do any permanent damage to the plants.

Epicoccum.—An undetermined species of this genus was obtained in three different cultures made from diseased cranberry vines from Olympia, Wash. Whether this was the cause of the diseased condition of the vine is not known.

Diplodia.—Dead cranberry vines collected at Wareham, Mass., and near Belleplain, N. J., bear a Diplodia not yet satisfactorily identified. The spores are brown, uniseptate, and measure 14 to 18 by 8 μ.

Chaetomium.—One or two species of this genus have occurred on leaves kept in a moist chamber and also in cultures made from cranberry stems and berries. In some cases they may have been due to contamination and in any event are probably not of pathological importance.

Oospora.—A fungus apparently belonging to this genus has occurred on leaves kept in a moist chamber.

Macrosporium.—An undetermined species of this genus has also been found in cultures and on leaves kept in a moist chamber.

PREVENTIVE AND REMEDIAL MEASURES.

REGULATION OF THE WATER SUPPLY.

Careful field studies have indicated beyond doubt that the physiological condition of the plants, as well as their environment, has much to do with their susceptibility to disease; therefore, anything which promotes the production of vigorous and hardy plants serves as a means of preventing the diseases to a certain extent. It is difficult, or impossible, on account of the very complex factors involved in the conditions of soil, moisture, and the plants themselves, to tell which are of most importance in their relation to the occurrence of diseases. Certain cranberry bogs, or portions of bogs, frequently show much more loss from diseases than others. From the experience of various growers, as well as from our own observations, it appears that the control of the water supply is a very important factor. The quantity of water necessary to keep the plants in the most vigorous condition depends largely upon the nature of the soil and subsoil, as well as the contour and natural drainage conditions of the land. The supply of water should be constant and capable of complete control, so as to avoid any great fluctuations during the growing season. In order to accomplish this, the water supply should be obtained from a reservoir rather than directly from a running stream. Some very successful growers find that keeping the water at such a level in the ditches that the surface of the bog

will be continually moist, but not wet, keeps the plants in the most healthy condition.

DESTRUCTION OF DISEASED VINES.

It is also important that steps should be taken so far as practicable to prevent the distribution and reproduction of the diseases by destroying all dead vines and leaves before the fungi have had opportunity to mature and set free their spores. Small areas of vines frequently die from the attacks of fungi and from other causes. All such vines should be pulled or cut and collected early in the season, at least within a week after the water has been drawn from the vines, and burned. Vines which have been cut in raking bogs to prepare them for scooping should also be destroyed in the same manner; otherwise the spores of the cranberry fungi develop in great numbers upon them and are a fertile source of infection for the young leaves and fruit. Little is to be feared from full-grown rotten berries, as the fungi very rarely produce any spores upon them.

SELECTION AND BREEDING OF RESISTANT PLANTS.

The selection of individual plants showing ability to resist the diseases is also an important means of avoiding them. It is a matter of common observation that some of the varieties are much more subject to disease than others. It may also be noticed that in any badly diseased area of vines there is occasionally one which bears sound fruit. By selecting and propagating these apparently resistant plants a variety much less subject to injury could probably soon be produced.

APPLICATION OF FUNGICIDES.

After determining the life histories of the most serious parasites causing the diseases it seemed very probable, judging from their relationships and the manner in which closely related species attack other fruits, that they could be successfully combated by the application of fungicides, the same as their relatives were. Experiments and tests of fungicides have been conducted for the past four years. Several kinds were used the first season, as already mentioned. Bordeaux mixture applied in the form of a spray proved much more satisfactory than any of the others. Besides these a dust Bordeaux mixture has been used quite thoroughly by one of the cranberry growers, but without any decided benefit.

BORDEAUX MIXTURE.

In the spraying experiments plats were selected where from 75 to 100 per cent of the crop had been lost by disease in former years. In the experiments of 1904 four applications of Bordeaux mixture were made during the season. In order to determine accurately the results, alternate plats were left unsprayed, as a check. According to actual counts of the sound and diseased berries made at picking time, from September 8 to 13, on 35-yard-square plats, representing the average condition of the sprayed and unsprayed areas, it was found that the greatest percentage of diseased fruit on any of the sprayed plats was 27.5, as against 100 per cent on the unsprayed plats. The minimum amount of disease on any of the sprayed plats was 13 per cent, as against 89 per cent on the check plats. The average number of diseased berries on all the sprayed plats was 21.7 per cent and on the unsprayed plats 76.8 per cent, and in addition to the protection of the fruit from diseases the general vigor and appearance of the sprayed plants was noticeably improved.

These experiments, owing to circumstances beyond our control, were not entirely satisfactory, as the applications of the fungicide were not made with sufficient frequency and at the most desirable time. In 1905 a more thorough and satisfactory series of experiments was conducted upon the same plats. The water was removed from the bog May 10 to 12. It is the usual practice of cranberry growers to flood the bogs from twenty-four to thirty-six hours during the first week in June, in order to destroy insects. It had been planned to spray part of the experimental plats before this second flooding. The water supply of the bog was, however, insufficient for a second flooding, and the relation of spraying to this operation was therefore not determined. Two of the plats were sprayed five times—May 19, June 22, July 14, July 31, and August 15. At picking time, September 8, accurate counts were made of all the diseased and sound berries on small areas which showed the average condition of the fruit on the sprayed plats. Counts were also made on equal areas showing the average condition of the fruit on the check plats. As a result of these counts it was found that there was an average of only 6 per cent of rotten fruit on the sprayed plats, while there was a little more than 91 per cent rotten on the unsprayed plats. Two other plats sprayed five times, but beginning June 2 instead of May 19, showed as a result of the counts made as in the experiment just mentioned an average of 2.36 per cent of diseased berries on the sprayed plats and 92.06 per cent of diseased fruit on the unsprayed plats. This appears to indicate that the application made on June 2 was more beneficial than that made at the earlier date, May 19.

Another plat was sprayed but four times, as follows: July 14, July 31, August 1, and August 15. Estimates of the amount of diseased fruit on the sprayed and unsprayed plats, made as in the previous cases, showed 18.3 per cent of rotten berries on the sprayed plat and 91.53 per cent on the unsprayed plat. This indicated what had already been anticipated, from our knowledge of the time of maturity of the parasites causing the diseases, that the earlier applications are exceedingly important, most of the infection apparently occurring before the fruit is half grown.

A portion consisting of 1,048 square feet of one of the plats which was sprayed five times was carefully hand picked and produced 3 bushels of sound fruit, this being at the rate of about 125 bushels per acre. The same area from the adjoining check plat gave a scanty peck of sound fruit, or 10.42 bushels per acre. In other words, there was twelve times as much sound fruit on the sprayed plat as on the unsprayed plat, or a saving of over 100 bushels per acre.

Preparation and application.—The method of preparation, as well as the dates and manner of application, is of exceeding importance in securing satisfactory results. The Bordeaux mixture should be freshly made. Good stone lime should be used, and from 3 to 5 pounds of commercial resin-fishoil soap should be added to it. In our first experiments, in which the plain Bordeaux mixture was used, it was found that the spray either collected in drops upon the surface of the leaves and fruit or ran off entirely, the surface of the cranberry leaves and fruit being so glossy that the mixture did not spread and adhere properly. It was found that by adding the resin-fishoil soap the mixture not only formed a film and spread over the surface of the leaves and fruit, but also adhered for a much longer time than the plain Bordeaux mixture.

The comparison of sprayed and unsprayed fruit at the time of picking does not show the full amount of profit to be derived from the treatment, as there is usually a considerable loss from the development of the diseases during the period between the time of picking and the time of marketing the berries. In order to compare the keeping qualities of the sprayed and unsprayed fruit, 2,400 perfectly sound berries, so far as could be determined by external appearance, were selected. Twelve hundred berries were from a sprayed plat and 1,200 from a check plat. They were all kept in the laboratory under similar conditions in order to determine the amount of disease which would develop in each case before the time for marketing the fruit. On October 18, the date upon which most of the fruit from the bog was marketed, and exactly one month from the date of picking, a careful examination of the 2,400 berries showed only 9.8 per cent of

the sprayed fruit diseased, while 38.1 per cent of the unsprayed fruit was diseased. In other words, four times as much of the unsprayed fruit as of the sprayed fruit decayed between the time of picking and marketing. The decay which developed was apparently caused by the dormant infection.

Cost of spraying.—The cost of spraying as it was done in these experiments averaged from $15 to $20 per acre, the Bordeaux mixture being applied at the rate of 4 barrels, or 200 gallons, per acre at each application, making for five applications a total of 1,000 gallons per acre. The cost would probably vary somewhat under different conditions and different methods, but in no instance should it exceed $20 per acre.

SUMMARY.

There are four serious fungous diseases of the cranberry—scald, caused by *Guignardia vaccinii;* rot, caused by *Acanthorhynchus vaccinii;* anthracnose, caused by *Glomerella rufomaculans vaccinii*, and hypertrophy, due to *Exobasidium oxycocci*. The first three diseases mentioned have heretofore been confused and considered as one.

Life history studies have shown that *Guignardia vaccinii* produces two forms of fructification—pycnidial and ascogenous—and is closely related to *Guignardia bidwellii*, which causes the black-rot of the grape.

Similar studies of *Acanthorhynchus vaccinii* reveal only ascogenous fructifications, but very striking and characteristic appressoria, which perhaps fill in part the place of a pycnidial form, are produced.

Glomerella rufomaculans vaccinii is also found to produce both conidial and ascogenous forms.

The production of ascogenous fructifications appears to depend in both *Guignardia vaccinii* and *Glomerella rufomaculans vaccinii* chiefly upon some inherent potentiality of the race, strain, or generation from which the hyphæ or spore used in the culture are derived. The composition of the culture medium and the conditions of temperature, moisture, and light are relatively unimportant factors.

The fungi producing scald, rot, and anthracnose, as well as *Pestalozzia guepini vaccinii*, are able to live in the tissues of cranberry leaves and fruit in a more or less dormant or noninjurious condition for a considerable period and may apparently at any time develop rapidly and destroy the tissues when conditions are favorable.

Thirteen other fungi have been found affecting cranberry fruit, most of which have, however, not shown indication of particular pathological importance. Sixteen different species have been found on either stems or leaves. Most of these do not seem to cause serious injury to the plant.

Preventive measures should include renovation of the cranberry bog, careful control of the water supply, and the cultivation of hardy and disease-resistant varieties.

Thorough treatment with Bordeaux mixture has proved successful in controlling the diseases. The addition of resin-fishoil soap is essential in order to make the mixture properly cover and adhere to the plants. As a result of five applications in 1905, only 2.36 per cent of the sprayed fruit was found to be destroyed at picking time, whereas 92 per cent of the unsprayed fruit on the plat adjoining was destroyed.

The cost of five applications, each of 200 gallons per acre, varies, according to the conditions and methods employed, from $15 to $20 per acre.

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DESCRIPTION OF PLATES.

PLATE I.—*Frontispiece.* Cranberry scald, showing different stages in the progress of the disease. A.—Early stage. B.—Later stage, showing dark zones. C.—Berry completely destroyed.

PLATE II.—Fig. 1.—A cranberry leaf, showing pycnidia of *Guignardia vaccinii* thickly scattered over the under surface; *a*, a cranberry blossom blasted by *Guignardia vaccinii*, showing pycnidia on calyx, corolla, and pedicel; *b*, a blasted fruit, showing pycnidia. Fig. 2.—A vertical section of a single pycnidium of *Guignardia vaccinii* from a cranberry leaf, showing pycnospores in various stages of development. Fig. 3.—An immature pycnospore of the same fungus, showing the partially formed appendage; *a*, the same, showing a little later stage of development; *b* and *c*, fully developed pycnospores and appendages. Figs. 4, 5, 6, 7, 8, and 9.—Various stages in the germination and growth of pycnospores of *Guignardia vaccinii* grown in weak sugar solution; 4, 5, 6, and 7, seventy-two hours after sowing; 8 and 9, eighty-six hours after sowing. Fig. 10.—A vertical section of a perithecium of *Guignardia vaccinii*, showing asci, from a cranberry leaf collected in New Jersey. Fig. 11.—Three asci, with ascospores showing variations in length of the stipe and the arrangement of the spores; *a* and *b*, from perithecia on a leaf; *c*, from a pure culture. Fig. 12.—A fresh, mature ascospore, showing the usual condition, in which the protoplasm is very coarsely granular. Fig. 13.—An old ascospore from a dried specimen, having its contents homogeneous. Fig. 14.—*a*, A portion of the coarse brown mycelium from the interior of a scalded berry, from which a culture was made December 23, producing pycnidia and ascogenous perithecia of *Guignardia vaccinii*; *b*, a portion of younger, lighter colored hyphæ from the same berry. Fig. 15.—*Pestalozzia guepini vaccinii*; *a*, a conidium having an apical appendage with three branches; *b*, a conidium having an apical appendage with four branches; *c*, a germinating conidium; *d*, a germinating conidium sending out two germ tubes.

PLATE III.—Fig. 1.—Vertical section through an acervulus of *Glomerella rufomaculans vaccinii* from the under surface of a cranberry leaf. Fig. 2.—Four conidia from the same, showing some of the variations in form and size. Fig. 3.—A portion of an acervulus of *Glomerella rufomaculans vaccinii* from a pure culture on corn meal, showing the dark-colored setæ which are occasionally found; *a* and *b*, conidiophores and conidia from another pure culture on corn meal. The conidiophores arise from a dark stromatic layer consisting of cells resembling appressoria, as shown in 3, *a*. No large acervuli, forming dense masses, occurred in this culture. Fig. 4.—Appressoria or chlamydospores from pulp of a cranberry from Massachusetts destroyed by *Glomerella rufomaculans vaccinii*. Fig. 5.—Portion of mycelium from corn-meal culture No. 736, forty-two days old. Conidia and appressoria found, fifteenth day; matured asci appeared the twenty-third day—no light spots seen in these. Where they appear they are probably due to the presence of vacuoles or oil globules. Fig. 6.—An ascogenous perithecium of the same

fungus grown in a pure culture. Fig 7.—Asci from the same; *a*, cylindrical form, with overlapping uniseriate spores; *b*, shorter subclavate form; *c*, ascus from older culture, showing shorter stipe. Fig. 8.—Fresh, mature ascospores from the same. Fig. 9.—Asci and fugaceous paraphyses from culture of *Glomerella rufomaculans vaccinii*. Fig. 10.—Portion of an acervulus of *Gloeosporium minus*, from a pure culture from a diseased New Jersey berry. Fig. 11.—Conidia from the same. Fig. 12.—A portion of a cranberry leaf, showing the slightly elevated epidermis and the protruding neck of *Acanthorhynchus vaccinii*. Fig. 13.—A single perithecium of the same fungus, taken from a pure culture on corn meal, showing portions of the hyphæ which form the thin, loose mycelial layer with which the perithecia are overgrown in artificial cultures. Fig. 14.—Asci and paraphyses from the same pure culture; *a*, a young ascus, in which the mature ascospores are surrounded by granular gelatinous matter; *b*, a slightly older stage; *c*, a nearly mature ascus, in which the granular protoplasm is shrunken about the spores and attached to the apex of the ascus. A portion of it remains as a thin gelatinous envelope about the spores after they are expelled from the ascus. Fig. 15.—Two ascospores of the same. Fig. 16.—A germinating ascospore, bearing the peculiar appressorium. Fig. 17.—An appressorium viewed from above. Fig. 18.—A group of appressoria attached to the surface of a cranberry leaf. Fig. 19.—A germinating appressorium grown in a poured plate. Fig. 20.—A germinating appressorium from the midrib of a leaf, showing superficial branching hyphæ. Fig. 21.—A section of a germinating appressorium on a leaf; *a*, a germ tube which has entered the leaf through a stoma. Fig. 22.—Another germinating appressorium; *a*, the germ tube entering the leaf through a stoma.

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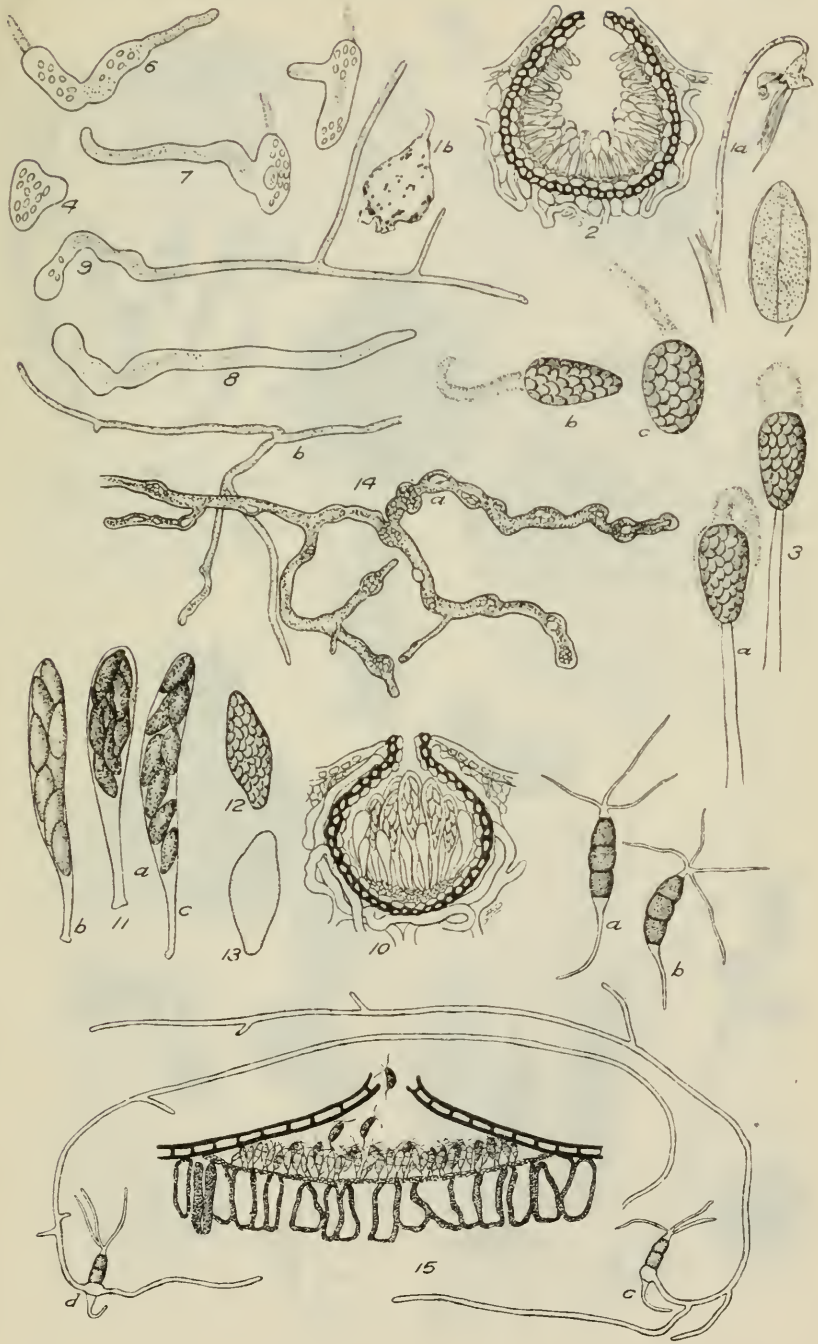
PLATE VI.—Cranberries destroyed by blast and scald. From a photograph. (Natural size.)

PLATE VII.—Cranberry Exobasidii. A and B.—*Exobasidium vaccinii*. C and D.—*Exobasidium oxycocci*.



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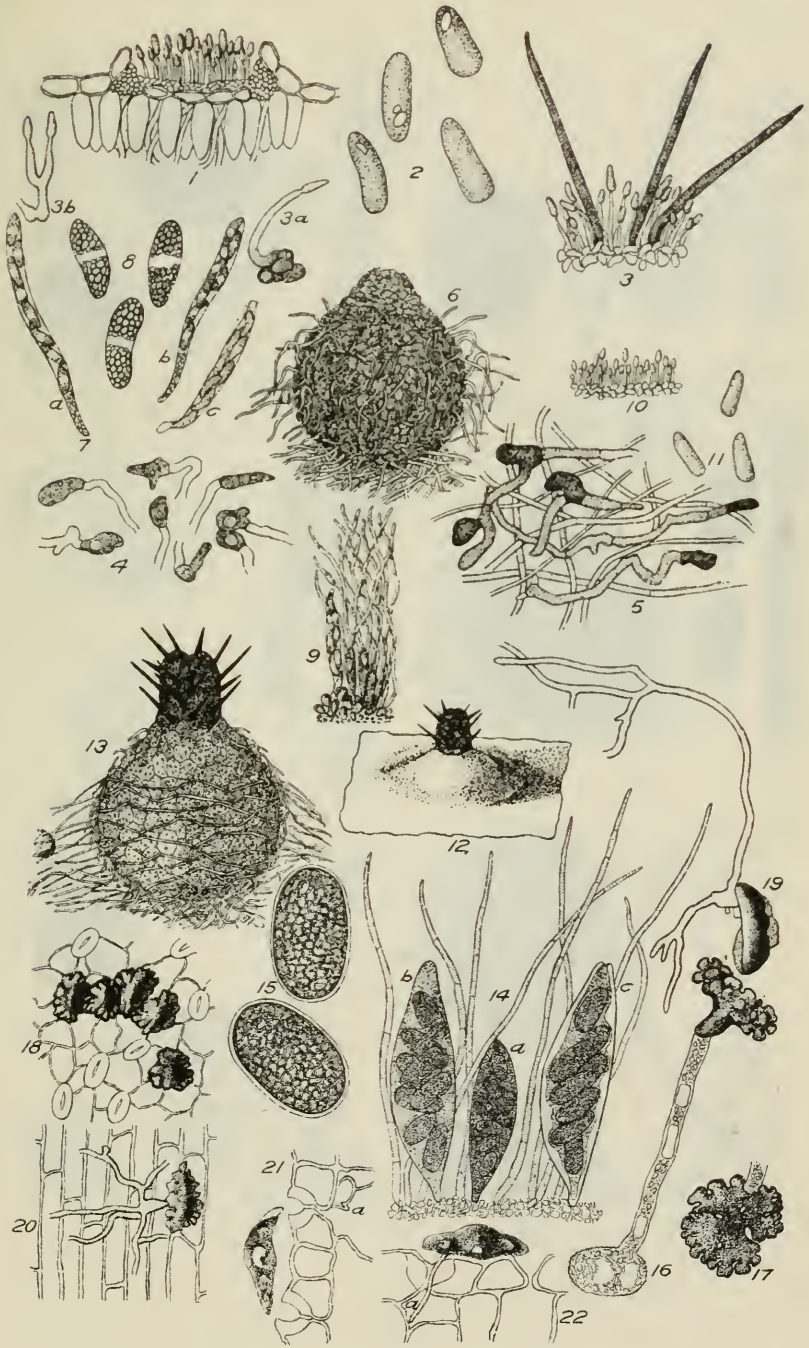

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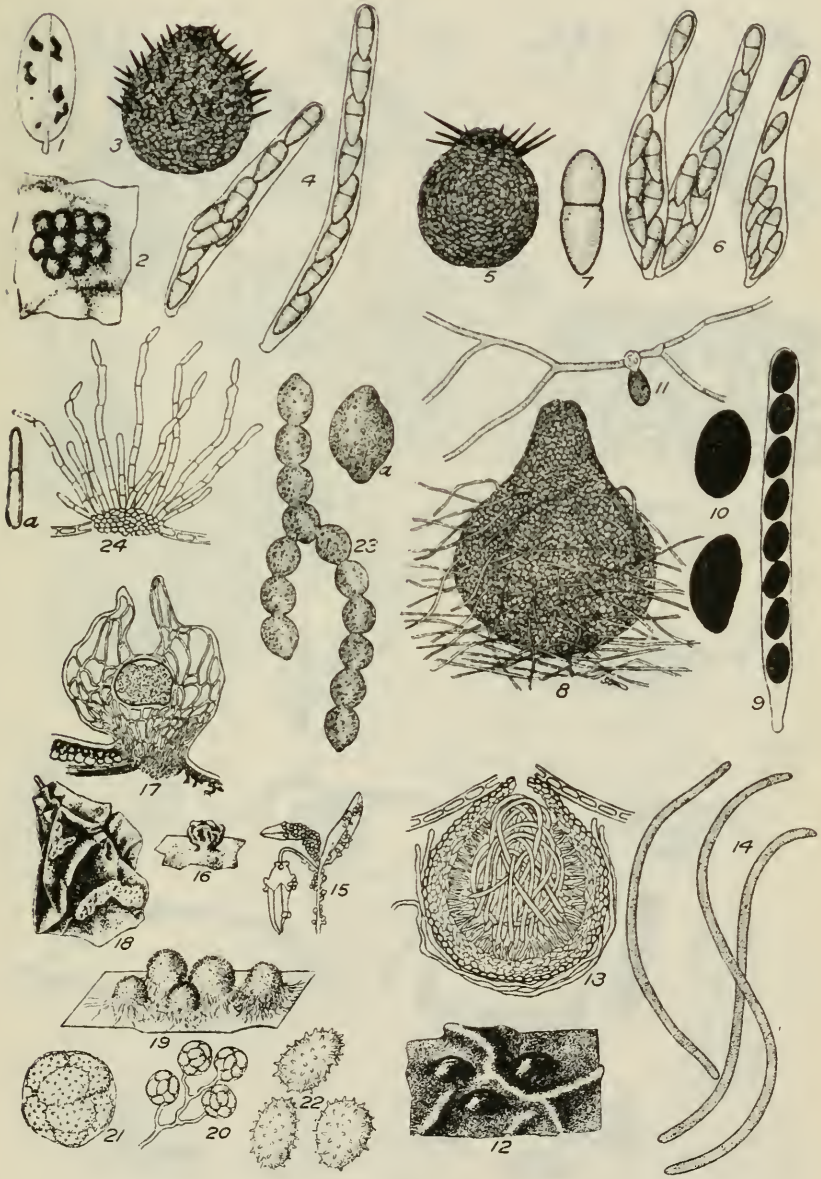
PLATE IV



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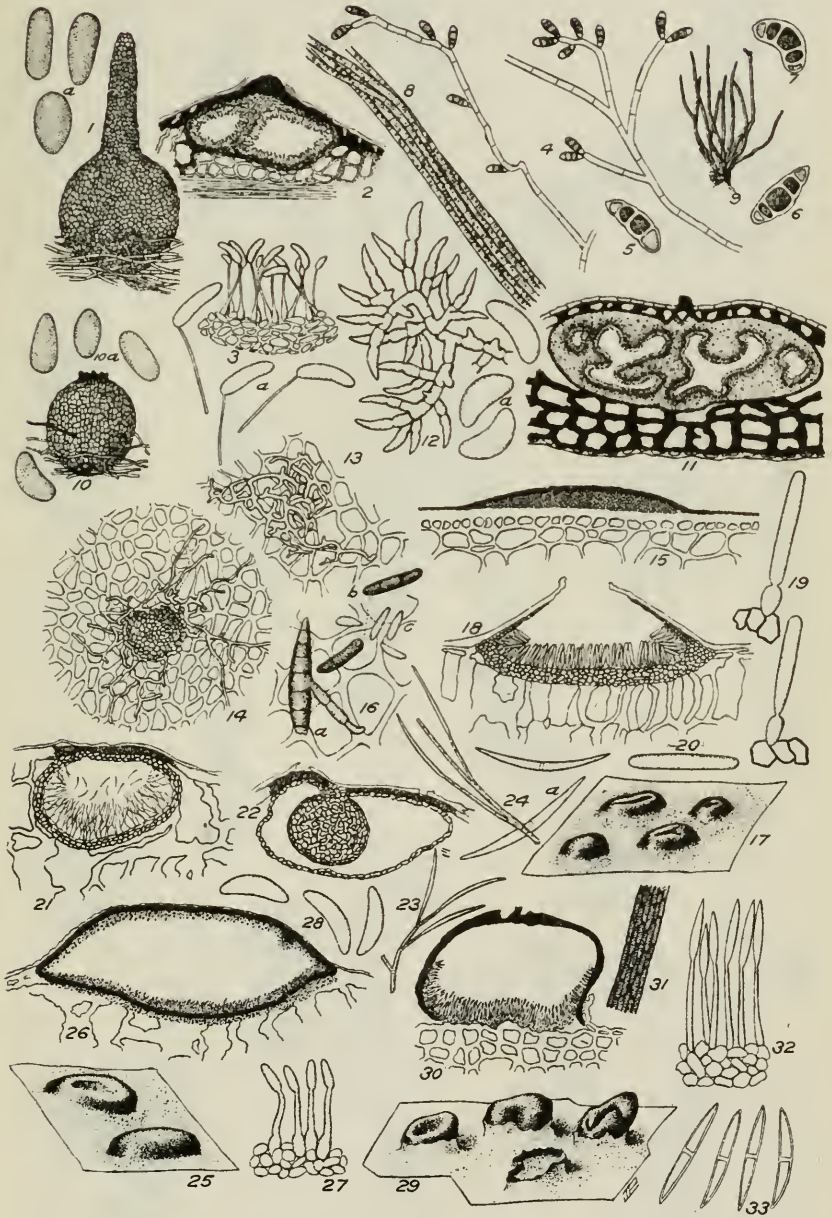

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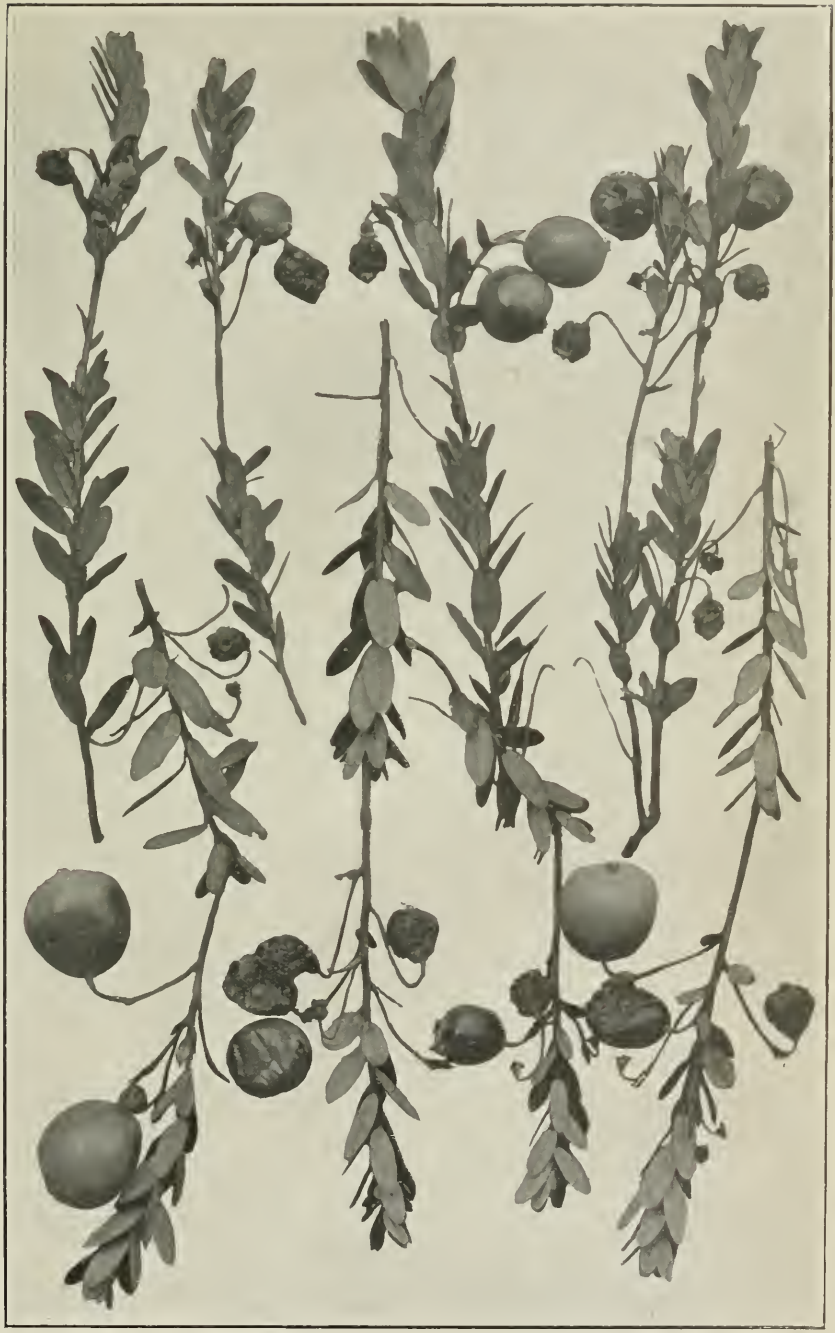

CRANBERRIES DESTROYED BY BLAST AND SCALD.

(Natural size.)

E. J. Schutt

A. HOEN & CO., LITH.

CRANBERRY EXOBASIDII.

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U. S. DEPARTMENT OF AGRICULTURE.

BUREAU OF PLANT INDUSTRY—BULLETIN NO. 111, PART I.

B. T. GALLOWAY, *Chief of Bureau.*

THE LARKSPURS AS POISONOUS PLANTS.

BY

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THE LARKSPURS AS POISONOUS PLANTS.[a]

INTRODUCTION.

Throughout the United States many species of larkspur (Delphinium) occur. Some of these form an important feature of the western landscape;[b] others, such as *Delphinium ajacis*, on account of their beauty have been cultivated in gardens, from whence they have escaped and become a pest to the farmer.[c]

The genus Delphinium is in a very confused condition botanically and needs revision.[d] However, the botanical characteristics of the genus are clearly marked and constitute sufficient reason for considering any plant bearing them as deserving of suspicion. *Delphinium trolliifolium* Gray, represented in the accompanying illustration (Plate I), shows these characteristics. In Canada[e] and in our Western States, especially in Colorado and Montana, various species of Delphinium have been accused of stock poisoning, although feeding experiments with these plants have varied in their results, and opinion in the West has been by no means uniform as to their poisonous properties. According to Wilcox,[f] in Montana 600 sheep were poisoned by *Delphinium menziesii* on one ranch, of which 250 died. In India the

[a] Of the many kinds of plants of the western ranges poisonous to stock, various species of larkspur are among the most destructive, especially in the mountainous regions of Colorado, Wyoming, and Montana.

About two years ago a study of the poisonous properties of one of the most common species was undertaken cooperatively by the Colorado Agricultural Experiment Station and the Office of Poisonous-Plant Investigations, the field collections and field tests being carried on by Dr. George H. Glover, veterinarian of the station, and the technical laboratory studies by Dr. A. C. Crawford, Pharmacologist of the Bureau of Plant Industry. The principal results of Doctor Crawford's work are here summarized.

It is shown that this larkspur is most virulent in its early stages and becomes much less active toward flowering time. The importance of the functions of elimination in bringing about recovery is also clearly indicated, and the significance of this fact in harmonizing the varying results of different investigations is pointed out.—Rodney H. True, *Physiologist in Charge of Poisonous-Plant Investigations.*

[b] Meehan, T. Delphinium Bicolor. Meehan's Monthly, vol. 12, p. 1. 1902.

[c] Rept. Comr. Agr. for 1865, p. 510.

[d] Huth, E. Monographie d. Gattung Delphinium. Bot. Jahrb., vol. 20, p. 322. 1895.

[e] Noxious Weeds and How to Destroy Them. Government of Northwest Territory, Dept. Agr. Bul. 2, p. 27. 1900.

[f] Chesnut, V. K. Preliminary Catalogue of Plants Poisonous to Stock. Ann. Rept. Bur. Animal Ind., 1898, p. 400.

dew from *D. brunonianum* is said to poison stock, and *D. restitum* is claimed to be poisonous to goats.[a] Similar reports come from France.[b] Chesnut and Wilcox, in particular, have brought this subject to public attention, Wilcox's field notes and post-mortem records being especially suggestive.[c]

The main symptoms seen in the poisoning of sheep by *Delphinium menziesii* were a stiffness of the limbs, with awkward gait; associated with this were involuntary muscular twitchings and loss of muscular coordination. Convulsions with marked rapidity in the pulse rate occurred. The respiration became shallow, but finally rapid. Wilcox fed the chloroform and benzol extracts of the dried plant to sheep, causing typical symptoms. He also called attention to larkspur poisoning in cattle.[d] This work was continued by Chesnut and Wilcox.[e] They fed and injected extracts of tall larkspur (*Delphinium glaucum*) and of purple larkspur (*D. bicolor*); but although these extracts produced some symptoms in rabbits and in sheep they failed to kill.

Nelson pastured a sheep during May in an area in which *Delphinium menziesii* was growing. This sheep ate all the Delphinium she could obtain herself, and in addition was fed 1,133.92 grams more, but showed no symptoms. A second sheep was fed 1,111.3 grams of the fresh plant in five days, but showed no symptoms. During the experiment this animal was deprived of all feed save the Delphinium.[f] Irish[g] experimented by feeding the plants growing in May to steers, feeding the tops of 24 plants of *D. trolliifolium* to one and the roots to another without results. He also fed 30 plants of white larkspur without results. He fails to state, however, how long his feeding continued. Glover's experiments[h] with rabbits were rather misleading, some dying, but most survived. Gerlach[i] fed *D. consolida* to sheep without results.

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[a] Watts, G. Dictionary of Economic Products of India, vol. 3, pp. 64, 70. 1890.

[b] Delaford, P. Traitè sur la maladie de sang des bêtes à laine, Paris, 1843, p. 173.

[c] Wilcox, E. V. Larkspur Poisoning of Sheep. Montana Agr. Expt. Sta. Bul. 15. 1897.

[d] Wilcox, E. V. Poisonous Plants of Montana. Montana Agr. Expt. Sta. Bul. 22, p. 45. 1899.

[e] Chesnut, V. K., and Wilcox, E. V. Stock-Poisoning Plants of Montana. U. S. Dept. Agr., Div. Botany, Bul. 26, p. 65. 1901.

[f] Nelson, S. B. Feeding Wild Plants to Sheep. Proc. Sec. Ann. Meeting Assoc. Expt. Sta. Veterinarians. 1898. U. S. Dept. Agr., Bur. Animal Ind., Bul. 22, p. 11.

[g] Irish, P. H. Plants Poisonous to Stock. Oregon Expt. Sta. Bul. 3, p. 25. 1889.

[h] Glover, G. H. Larkspur and Other Poisonous Plants. Colorado Agr. Expt. Sta. Bul. 113, p. 17. 1906.

[i] Dammann, C. Gesundheitspflege, 1886, p. 841.

DELPHINIUM TROLLIIFOLIUM, GRAY.

LABORATORY EXPERIMENTS WITH DELPHINIUM CAMPORUM.

Specimens of *Delphinium camporum* were sent from Fort Collins, Colo., for testing in the laboratory of Poisonous-Plant Investigations. Five grams of the dried and powdered plant were accurately weighed and then extracted over night with 20 c. c. of water and 10 c. c. of 95 per cent alcohol. The alcohol was added mainly as a preservative. The following day the extraction and squeezing were continued until the fluid became colorless. The fluid was evaporated on the next day in vacuo at about 40° C., and the residue was dissolved in water and made up to 30 c. c.—perfectly arbitrary figures. Of this aqueous solution 1 c. c. injected subcutaneously into a guinea pig weighing 730 grams caused no disturbance, and 3 c. c. were also without effect, whereas 6 c. c. killed the same guinea pig in 55 minutes. A solution of 4 c. c. injected into a guinea pig weighing 352 grams caused no symptoms, while 6 c. c. injected into another guinea pig weighing 285 grams killed in 33 minutes. Later, 5 c. c. killed a guinea pig weighing 196 grams in 55 minutes, while 4 c. c. injected into a guinea pig weighing 299 grams gave no symptoms. Evidently the lethal dose of this solution lies between 4 and 5 c. c. The solution used in the above experiments was made from plants collected on April 26, 1905.

On May 16 another lot of material was collected, and a solution corresponding to 4 c. c. of the first batch was injected into a guinea pig weighing 455 grams without producing any symptoms. However, 5.3 c. c. of this solution killed a guinea pig weighing 350 grams, but a much longer period elapsed before death occurred than with the extract of the first material.

In June another lot of material was collected, and a solution of this corresponding to 4 c. c. caused no symptoms in a guinea pig weighing 376 grams; 5.3 c. c. caused no symptoms in a guinea pig weighing 500 grams, and 6.6 c. c. was inactive in a guinea pig weighing 480 grams. Of the dried material 10 grams were then extracted, and killed a guinea pig weighing 320 grams only after about 10 hours. A control amount of plain distilled water failed to kill. The lethal dose is evidently much higher than in the second stage.

There is no question as to the fact that Delphinium when injected subcutaneously will kill, and these experiments also establish the fact that the plant loses much of its toxicity as it approaches the flowering stage. It has been noted that *Delphinium consolida* is also less active when mature.[a]

Just after flowering, the purple larkspur turns yellow and ceases to

[a] Dammann, C. Gesundheitspflege, 1886, p. 1072.

be attractive, so that there is less danger of poisoning,[a] although Chesnut and Wilcox report a death in cattle from eating *Delphinium glaucum* in September.[b] The great danger early in the season seems to arise from the fact that the Delphinium appears early in the spring, and the ground may again be covered with snow, so that it is the only green plant in sight, and therefore when in an especially poisonous stage it is eaten by cattle.

A rabbit weighing 2,409.66 grams was fed January 28, 1907, with a concentrated aqueous extract corresponding to 16.66 grams of the dried plant in the second stage. No symptoms resulted. On January 30 the animal weighed 2,377.15 grams.

On January 28, 1907, a second rabbit, weighing 1,658.35 grams, was fed with a similar extract of 33.33 grams, but no symptoms resulted. Two days later the animal still weighed 1,658.35 grams.

On February 1, 1907, the first rabbit was fed an aqueous extract of 80 grams, and it died in 53 minutes with convulsions. Previous to death, paralysis of the voluntary muscles was well marked. The stomach of this animal was markedly reddened.

A rabbit weighing 1,984.41 grams on February 6, 1907, was starved 24 hours and then fed an extract of 50 grams of the same plant at 9.45 a. m. At 11.50 a. m. the animal was dull and was lying with its chin resting on the floor; at 12.25, legs paralyzed; 3.04, the animal urinated, chin still resting on the floor; 3.57, the animal could push itself around with hind legs. The following day the rabbit appeared normal. On February 11 it weighed 1,899.39 grams; February 12, 1,956.07 grams; February 13, 2,012.75 grams; March 11, 1,984.41 grams.

On February 13, 1907, a well-fed rabbit, weighing 2,097.77 grams, which had been in the laboratory for some time, was fed by stomach tube an aqueous extract of 50 grams of the same plant. This animal was observed continuously for 6 hours and appeared perhaps only slightly duller. He ate during the night, and weighed 2,119.94 grams on February 14. During the night no stools were passed. On February 16 this rabbit weighed 1,970.24 and on February 21, 2,012.75 grams.

The urine passed the first 24 hours after feeding was alkaline. Some of this was shaken with chloroform and on evaporation was taken in acid water. On evaporating off the acid, the watery solution was injected subcutaneously into a guinea pig weighing 467.76 grams, but produced no symptoms. The urine secreted in the following 24

[a] Wilcox, E. V. Plant Poisoning of Stock in Montana. U. S. Dept. Agr., Bur. Animal Ind., 17th Ann. Rept., 1900, p. 96.

[b] Chesnut, V. K., and Wilcox, E. V. Stock-Poisoning Plants of Montana, p. 67.

hours was added to the first and the whole shaken out with benzol. This, after taking up with acid water, was injected into the same guinea pig. The animal soon became very dull, walking with waddling gait when forced to move, being evidently affected by the poison. Two days later the animal was normal. The urine of a control rabbit, similarly shaken with benzol, produced no such symptoms in this guinea pig.

On February 11, 1907, an aqueous extract of 5 grams was injected subcutaneously into a rabbit weighing 666.14 grams. An hour and three minutes later the animal was unable to stand, and soon developed convulsive movements of the limbs. This animal was expected to die at any time during the afternoon, but gradually improved and appeared slightly duller than normal the following day. On February 13 it weighed 613.61 grams; February 25, 595.29 grams; and on March 16, 552.78 grams, showing a steady diminution in weight.

An extract of 9.5 grams injected subcutaneously into a rabbit weighing 2,182.79 grams was without immediate effect.

An aqueous extract of 20 grams when injected into a rabbit weighing 481.93 grams soon caused paralysis of the limbs, and the rabbit died in 32 minutes.

On February 11, 1907, a rabbit weighing 1,417.46 grams was opened under ether, and the mouths of the ureters were tied off, together with the bladder, to prevent elimination by the urine. An aqueous solution corresponding to 34 grams of the same plant was then fed by mouth. This animal remained dull all the afternoon, and at 4.45 p. m., 4 hours and 45 minutes after the feeding, he was resting with his chin on the cage. He was found dead and stiff at 9.15 p. m., having evidently died some time previous. A post-mortem showed the ureters distended and sharply outlined.

Another rabbit weighing 1,743.37 grams was prepared in a similar manner by tying off the ureters and bladder and was fed with an extract of 50 grams. In 1 hour and 47 minutes this animal was paralyzed and unable to stand, breathing very slowly, and died 6 minutes later. The ureters were found dilated as in the previous case, and the stomach was slightly reddened.

A control for these two rabbits was prepared in a similar manner at the same time as the others. Nine hours after the operation, when the two rabbits which were fed the Delphinium were dead, this rabbit was bright and running about, but was then killed with chloroform to prevent suffering.

In these cases it is necessary to consider not only the effects of nonelimination but also the fact that the power which the liver possesses of storing up and removing injurious bodies from the circulation may

be interfered with, as Mosse[a] has proved that starved and nephrectomized rabbits show histological changes in the liver cells.

On February 20, 1907, a well-fed rabbit weighing 1,403.29 grams was etherized for 12 minutes and then fed an extract of 50 grams to see if the increased toxic action of the plant was due to any interference with the metabolism caused by the ether. On February 23 this animal showed no symptoms, weighing 1,360.78 grams, and on February 25 the weight was 1,403.29 grams. The urine collected in 60 hours was shaken with benzol, as it had previously been found that much, if not all, of the active principles of *Delphinium camporum* goes into the alkaline benzol shaking by the Dragendorff method. The residue from the benzol evaporations was then taken up with acetic acid water. On removing the acid by heat a few drops were injected into the dorsal lymph sac of a male frog (*Rana clamitans*) weighing 35 grams. This animal soon became paralyzed and was unable to move, but recovered over night. The following day a few more drops were injected with the same result, showing that some of the active principle of the Delphinium was eliminated with the urine.

From these experiments it can be seen that aqueous extracts of *Delphinium camporum* will kill rabbits on subcutaneous injection, and also by mouth if the dose is large, while much smaller doses will kill if the elimination is interfered with, as by tying off the ureters, or after starving, a condition which intensifies the action, probably by accelerating absorption. What seems to be the cause of the uncertainty in the results, especially in the lack of striking results in the feeding experiments, is that no consideration was given to the fact that the poisoning in this case may be simply the resultant of the excretion and absorption of the plant; in other words, that very little of the plant may be taken up by the gastro-intestinal tract and that this may be eliminated by the kidneys before a poisonous dose has been absorbed, so that the question of poisoning becomes one of rapidity of absorption. This is well known to be the case with curare, where the administration by mouth, except in large doses, is not likely to prove poisonous unless the elimination is interfered with as by tying the ureters.[b] Consequently the conditions most favorable for poisoning on the range would be those which aid the more thorough extraction of the poisonous principle from the plant by the gastro-intestinal tract, thus favoring absorption, and those which interfere with the elimination by the kidneys or interfere with the storing of the poison by the liver, as renal and hepatic disease or lack of salts, which normally increase diuresis.

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[a] Mosse, M. Ueber Leberzellenveränderungen nephrektomierter u. hungernder Thiere. Zeits. f. Klin. Med., vol. 60, p. 373. 1906.

[b] Brunton, T. L. Text-Book of Pharmacology, 3d ed., London, 1893, p. 38.

A striking feature about these rabbits is that in some cases while the dose was not sufficient to kill immediately they gradually lost in weight, probably a direct result of the irritation of the gastro-intestinal tract. This condition may find its parallel in stock removed from a Delphinium area. Knowles[a] and Wilcox[b] have claimed that the inhalation of a few drops of ammonia and the hypodermic injection of atropin, $\frac{1}{6}$ to $\frac{1}{4}$ gram (1 mg. to 15 mg.) for sheep, or 1 gram (60 mg.) for cattle, is the most effective medicinal treatment. Elimination by purgatives and diuretics may aid. If possible, absorption from the gastro-intestinal tract should be hindered, perhaps by lard, but the real treatment is preventive.

One member of the genus Delphinium, *D. staphisagria*, has been studied carefully, and a number of bases (delphinin, delphinoidin, staphisagrin) isolated, but much is still to be desired in the way of exact knowledge concerning these bodies.[c] Delphinin has a local irritative action. Its systemic action is mainly paralytic on the heart and respiration, and resembles that of aconitin in many respects.[d] Post-mortem examinations in poisoning by mouth with this body showed marked reddening of the stomach. In a number of Van Praag's experiments with feeding solutions of Delphinium a marked increase in urinary secretion was noted.[e] *Delphinium consolida* has also received some attention chemically,[f] while *D. leroyi*, *D. peregrinum*, and *D. mauritanicum* have been shown to produce poisoning experimentally.[g]

Recently *Delphinium bicolor*, *D. menziesii*, *D. nelsonii*, and *D. scopulorum stachydeum* have been found to yield an alkaloid, delphocurarin,[h] which has been introduced as a substitute for curare in

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[a] Knowles, M. E. Larkspur Poisoning in Sheep and Cattle. New York Med. Jour., vol. 66, p. 271. 1897.

[b] Wilcox, E. V. Larkspur Poisoning of Sheep, p. 45.

[c] Dragendorff and Marquis. Ueber d. Alkaloide des Delphiniums staphisagria. Arch. f. Exp. Path. u. Pharmakol., vol. 7, p. 55. 1877.

Kara-Stojaiow, C. Ueber d. Alkaloide d. Delphinium staphisagria. Pharm. Zeits. f. Russland, 1890, vol. 29, pp. 628, 641, 657, 673, 689, 705, 721.

[d] Tamburini, N., and Leone, A. Azoine fisiol. della Delfinina. Gior. Internaz. d. Sci. Med., n. s., vol. 3, p. 985. 1881.

Orfila, M. Traité de toxicologie, 5 ed., vol. 2, p. 138. 1852.

[e] Van Praag, J. L. Delphinin. Arch. f. Path. Anat., vol. 6, p. 439. 1854. Sereck. J. Beitr. z. Kennt. d. Delphinins. Dorpat Diss. 1874.

Darbel, A. Recherch. Chim. et physiol. sur les alcaloides du Delphinium staphisagria. Montpellier. Thèse. 1864.

[f] Masing, E. Ueber d. Alkaloid d. Feldrittersporns. D. consolida. Pharm. Zeits. f. Russland, vol. 22, p. 33. 1883.

[g] Rochebrune, A. T. de. Toxicol. Africane, vol. 1, pp. 152, 161, 353. 1896.

[h] Feinde der Haustiere und ihre giftige Principen (Delphocurarin). Pharm. Centr., vol. 44, p. 913. 1903.

vivisection work, and this introduction is indorsed by Lohmann's work.[a]

Schiller[b] corroborates Lohmann's results, but claims that curare is efficient for muscle physiological work in smaller doses than is the delphinin of Heyl.

This use of Delphinium certainly offers a field which should be investigated commercially, as curare is likely to be uncertain in its action.[c] Methyl delphinin is said also to possess this curare-like action.[d]

The coloring matter of the flowers of *Delphinium zalil* has been utilized as a dye.[e] Other Delphiniums, such as *D. ajacis*, have been recommended for insecticidal uses, and especially on account of cheapness.[f]

Froggatt states that common garden larkspur will kill locusts, and advises planting them in masses around gardens and orchards to protect against the ravages of these insects.[g] The same claim is made as to its action against grasshoppers.[h]

Delphinium coeruleum has been used to kill maggots and *D. brunonianum* to destroy ticks.[i] This latter plant has been used to some extent as a substitute for musk.

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[a] Lohmann, A. Unters. über d. Verwerthb. eines Delphinin präp. an Stelle d. Curare in d. muskelphys. Technik Pflüger's Arch. f. Ges. Physiol., vol. 92, p. 473. 1902.

[b] Schiller, V. Ueber d. physiol. Wirkungen d. Delphinins (Heyl). Arch. f. Anat. u. Physiol., Physiol. Abtheil., p. 248. 1904.

[c] Merck, E. Ann. Reports, 1902, vol. 16, p. 48.

[d] Kobert, R. Lehrb. d. Intox., 2d ed., p. 1185.

[e] Aitchison, J. E. T. Some Plants of Afghanistan. Pharm. Jour. and Trans., vol. 17, p. 466. 1887.

[f] Amer. Jour. Pharm., vol. 55, p. 50. 1883.

[g] Froggatt, W. W. Plague Locusts. Agr. Gaz. New South Wales, vol. 11, p. 181. 1901.

[h] Bailey, J. F. Hemp. Queensland Agr. Jour., vol. 2, p. 200. 1898.

[i] Watts, G. Dictionary of Economic Products of India, vol. 3, pp. 64–65. 1890.

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U. S. DEPARTMENT OF AGRICULTURE.
BUREAU OF PLANT INDUSTRY—BULLETIN NO. 111, PART II.
B. T. GALLOWAY, *Chief of Bureau.*

THE FIBERS OF LONG-STAPLE UPLAND COTTONS.

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II. Seeds of cotton combed out to show the so-called longer fibers. *A*.—Columbia variety. *B*.—Griffin variety 4

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2. A few extra-long cotton fibers, showing two fibers united 6

3. Cotton fibers tied together, very much magnified 7

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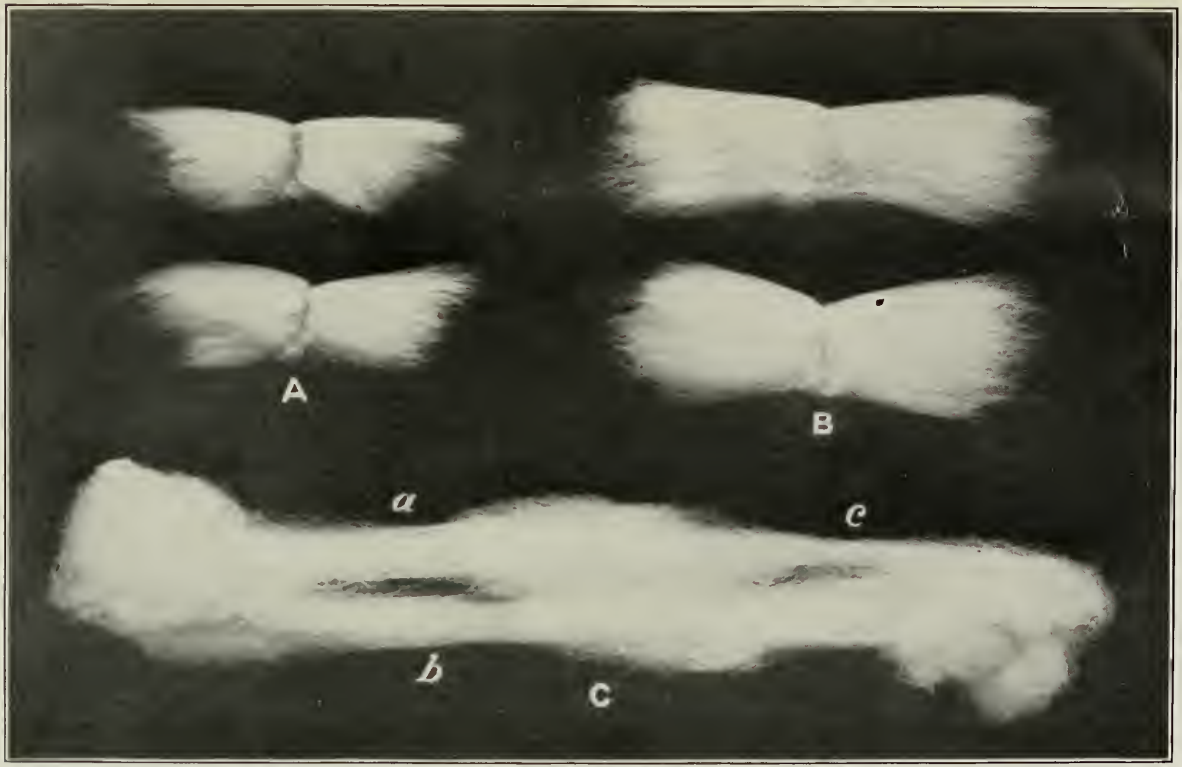
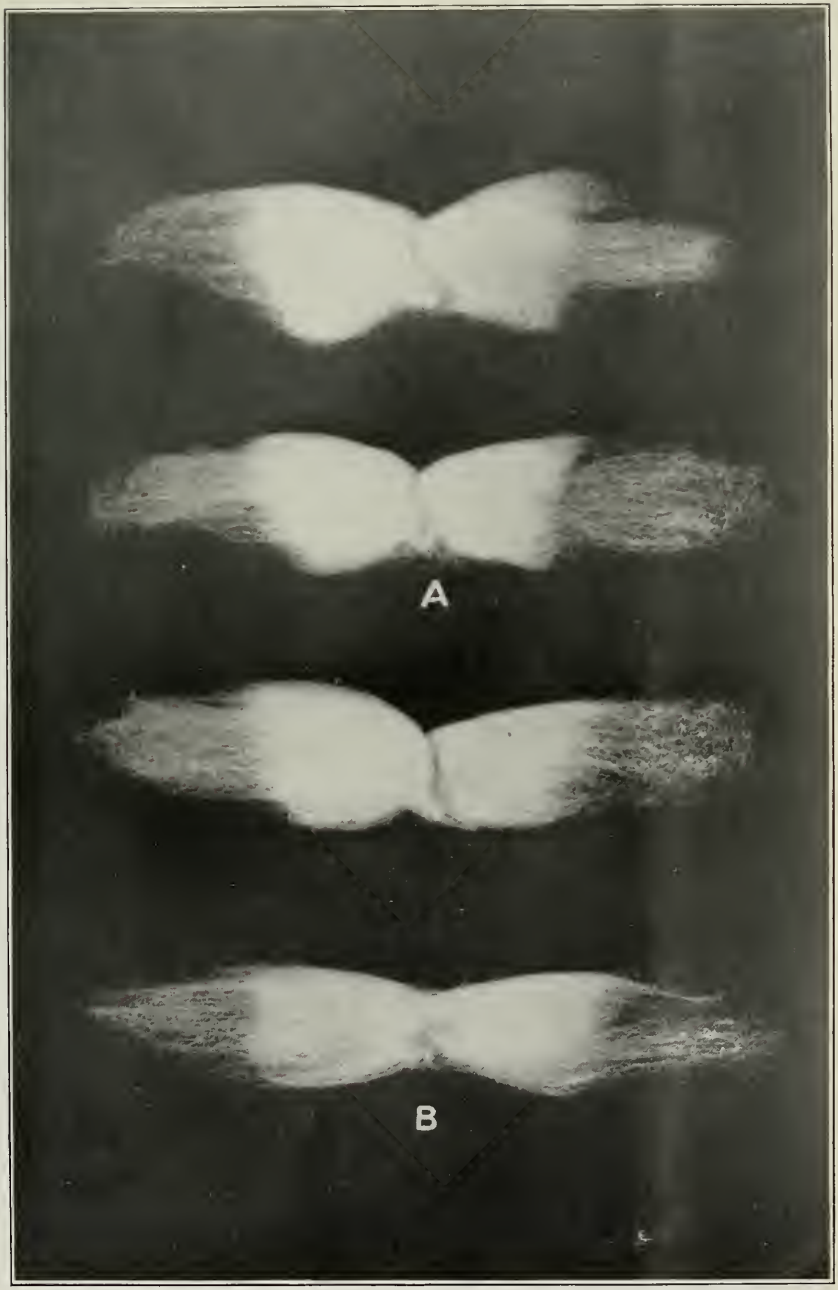


COTTON SEEDS WITH FIBERS ATTACHED.

A and *B*.—Cotton seeds with fibers combed out to show uniformity and nonuniformity in the length of the fibers. *C*.—Lock of Griffin cotton stretched so as to show points of origin of longer fibers—*a*, *b*, and *c*.



SEEDS OF COTTON COMBED OUT TO SHOW THE SO-CALLED LONGER FIBERS.

A.—Columbia variety. *B*.—Griffin variety.

B. P. I.—305.

THE FIBERS OF LONG-STAPLE UPLAND COTTONS.

UNIFORMITY OF COTTON FIBERS.

In investigations in cotton breeding where an improvement in certain lint characters is desired several factors must be carefully considered. Among these, some of the most important are fineness of lint, the relative yield of lint to the total yield of seed cotton, and the uniformity of length of all the fibers when properly combed out and examined. The last character, uniformity of length, is a most important one and has much to do with subsequent waste and the production of good yarns in the process of manufacture.

On Plate I are illustrations of cotton seeds with fibers combed out to show uniformity and nonuniformity in the length of the fibers. The seeds to the left (A) show very poor uniformity and are of the "butterfly" type, as they are commonly called. In marked contrast, the seeds to the right (B) show excellent uniformity as a result of several generations of careful selection.

APPARENT LACK OF UNIFORMITY AND ITS OCCURRENCE.

There is an apparent lack of uniformity which deserves considerable attention from the standpoint of cotton growers and breeders. Plate II illustrates this character, although it is more strikingly brought out in the operation of detaching the seed from the lock. From the illustration there would appear to be a great lack of uniformity, due to a group of fibers about twice the length of the general covering. This group arises from the center of the main body of fibers or, often, from those having a point of attachment near the larger end of the seed. This character is usually associated with the finer, more crinkly types of long-staple cottons, such as the fine, long-linted Egyptian and Sea Island varieties and the long-staple Upland varieties—Griffin, Allen, Cook, etc. It is a character which becomes more apparent as a variety is being rigidly selected generation after generation for finer, longer staple. This has been well illustrated in the improvement of the lint characters of the Russell variety and, to some extent, the Jones variety. The orginal condition

of both of these varieties is remarkably free from this so-called longer group of fibers. In the case of the greatly improved Russell strain, which has become distinctive enough in good lint characters and yield to be designated as a new variety—the so-called Columbia cotton—these longer fibers are evident to a remarkable degree.

THE TRUE NATURE OF THE LONGER FIBERS.

It has been more or less the rule with cotton breeders and cotton growers acquainted with the requisites of desirable lint characters to regard these extra-long fibers as an unfavorable feature. In this light they meant a variation toward nonuniformity. In the work of selection, to avoid as much as possible a perpetuation of this sort of variation, plants showing this character most markedly were regarded with suspicion and later even discarded, although in other respects they were among the best in the field.

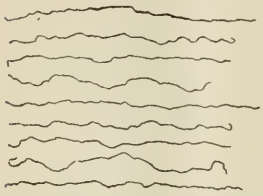


FIG. 1.—Single cotton fibers from the so-called longer group of fibers.

A careful examination leads to the conclusion that these fibers should be regarded in a wholly different light. *They are not longer fibers as they have been generally considered, but are caused by more or less curling and interweaving, which results in the pulling out of fibers from adjacent seeds.*

In the ordinary manner of stretching the locks to determine the drag, the fibers are slowly separated and drawn out, and at those points of greatest binding, as shown in Plate I, C, *a*, *b*, and *c*, the groups of longer fibers appear to rise. If, now, a single seed is selected and detached from the rest and the entire group of fibers loosened from its attachment to the seed coat in the neighborhood of the longer groups, one can with fine forceps draw these fibers out carefully and compare their length with those of the rest of the seed.

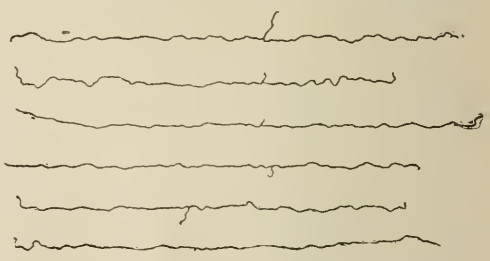


FIG. 2.—A few extra-long cotton fibers, showing two fibers united.

In many instances the single fibers now readily separate, since the tension of pulling has ceased. Several of these single fibers are shown in figure 1. In some instances fibers nearly twice the normal length are drawn out. Oftentimes with the naked eye the point of union or tying may be discerned by the tiny loose ends, as is shown in figure 2. In other cases, however, this point of union is so intimate that only a high microscopic power can make it evident. Figure 3 illustrates various

degrees of this tying or curling together, as seen when greatly magnified. In figures 1 and 2 single and united fibers, respectively, of natural length are shown, but the diameters are of necessity much greater than normal, owing to the exceeding fineness of the fibers.

The drag of cottons showing the longer fibers previously described gives a more extended, elastic tension than is manifest among the short-staple varieties. It is probable that breeders may find this character a useful one in indicating a tendency toward increased length, fineness, and crinkliness of staple in the individuals in which it occurs most noticeably—an indication of better spinning quality.

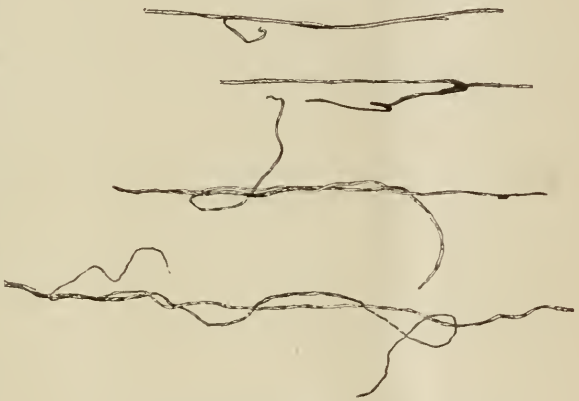


FIG. 3.—Cotton fibers tied together, very much magnified.

It is important that breeders and growers of long-staple cottons should know that these apparently longer fibers are no indication of true lack of uniformity. The presence of these fibers in the long-staple Upland varieties has quite universally led to the erroneous belief that such cottons are rather inferior in uniformity as regards length of fibers. The Griffin cotton, in particular, recognized in other respects as the best long-staple Upland cotton grown, has always been described as decidedly unsatisfactory so far as uniformity in length of staple is concerned, since the drawing out of fibers from adjacent seed is a marked characteristic of this variety.

A knowledge of the true nature of these longer fibers will clear the reputation of some of the best long-staple Upland varieties of a serious fault hitherto wrongly attributed to them by all breeders and growers.

O

U. S. DEPARTMENT OF AGRICULTURE.

BUREAU OF PLANT INDUSTRY—BULLETIN NO. 111, PART III.

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IMPORTED LOW-GRADE CLOVER AND ALFALFA SEED.

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IMPORTED LOW-GRADE CLOVER AND ALFALFA SEED.

INTRODUCTION.

During the calendar year 1906 the United States exported 3,615,873 pounds of clover seed, and during the latter half of the same year imported 6,306,561 pounds, the exports for the year being only a a little more than one-half the imports for six months. The same condition holds true with alfalfa seed, the imports far exceeding the exports. The relatively large importation of these seeds results from short crops in this country and a constantly increasing demand on account of the new land being brought under cultivation and the extension of diversified farming.

Illustrations of typical samples of imported red clover and alfalfa seed of good quality and that of low grade are shown in Plate I.

WHY LOW-GRADE SEED IS IMPORTED.

In Europe seed testing has been gradually growing in favor for forty years and is now recognized as an important aid to agriculture. All the European countries, with the exception of Spain and Turkey, have seed-testing stations, varying in number from one in Italy to twenty-eight in Germany. Each of them has the necessary equipment for making complete tests of seed, both for mechanical purity and for germination.

The test for mechanical purity as conducted in these stations includes not only the determination of the percentage of pure seed and of other seeds and dirt, but also the size and source of the seed. The source of the seed is determined by the characteristic weed seeds which are found. While errors are no doubt made, these determinations are of great value in showing that at least a part of the seed was raised in a certain section, and they furnish information as to the probable adaptability of the seed to local conditions. Through the work of these stations the people have come to appreciate the importance of good seed, and as the greater part of that now used in Europe is sold on the basis of accurate tests for mechanical purity and germination the sale of low-grade seed has been greatly reduced.

A similar condition exists in Canada, where there is a strict law governing the quality of seed sold. In this country, however, only

three States have any effective legislation restricting the sale of seeds within their borders. Several of the agricultural experiment stations are preparing to undertake seed testing, but their equipment is limited and the number of samples handled is small. At present there are no Federal restrictions on the importation of low-grade and worthless seed. As a natural result the United States has become the dumping ground for the poor seed of Canada and Europe.

ANALYSES OF IMPORTED LOW-GRADE SEEDS.

RED CLOVER.

Table I gives the analyses of sixty-one lots of low-grade red clover seed imported during the fiscal year ended June 30, 1906, amounting to 990,809 pounds. The total importations of red clover seed for the same period amounted to 7,498,287 pounds, so that the low-grade seed furnished about one-eighth of the total. These low-grade importations contained seed enough to sow approximately 125,000 acres at an average rate of seeding. This seed is for the most part small-sized, light-weight screenings. A practical failure must be expected whenever seed of this quality is used, either from not securing a stand on account of poor germination or from smothering with introduced weeds.

TABLE I.—*Analyses of 61 samples of low-grade red clover seed imported during the year ended June 30, 1906.*

Number of seed sample.	Red clover seed.	Other seeds.	Dirt and broken seed.	Dodder present.[a]	Kinds of weed seeds.	Weight of 1,000 red clover seeds.	Germination of red clover seed.	Quantity imported.[b]	Price per 100 pounds at which seed was imported.	Live red clover seed (seed that germinated) in sample.	Actual cost of 100 pounds of red clover seed that germinated.
	Per cent.	*Per cent.*	*Per cent.*		*Number.*	*Milligrams.*	*Per cent.*	*Pounds.*		*Per cent.*	
2945	48.06	25.78	26.16	No.	39	882	38	6,740	$5.20	18.26	$28.48
2946	66.1	13.16	20.74	Yes	27	900	91	5,027	7.60	60.15	12.63
2947	77.43	9.44	13.13	Yes	32	1,135	83	6,876	9.10	64.27	14.16
3101	72.5	25.73	1.77	No.	10	1,594	96.5	3,750	11.00	69.96	15.72
3159	73.14	10.38	16.48	Yes	25	893	88.5	16,535	8.00	64.73	12.36
3222	73.8	7.88	18.32	Yes	24	810	89	13,380	7.20	65.68	10.96
3395	70.41	10.90	18.69	Yes	20	779	76.5	30,857	7.00	53.86	12.99
3400	75.78	9.35	14.87	Yes	28	895	80	32,706	7.75	60.62	12.78
3425	70.05	21.89	8.06	No.	33	1,377	77.5	32,630	8.00	54.29	14.73
3432	74.39	15.02	10.59	Yes	50	951	75.5	22,000	8.00	56.16	14.24
3456	43.03	19.31	37.66	Yes	39	855	28.5	25,300	2.80	12.26	22.84
3457	46.24	19.09	34.67	Yes	32	818	27.5	35,347	6.10	12.72	47.95
3488	63.31	23.22	13.47	No.	29	913	68	35,350	5.80	43.05	13.47
3566	69.81	12.25	17.94	Yes	23	847	72	32,893	7.50	50.26	14.92
3571	67.89	16.67	15.44	No.	29	995	66.5	29,490	9.20	45.15	20.37
3587	67.55	13.50	18.95	Yes	45	898	60.5	7,015	7.10	40.87	17.37
3588	76.74	14.53	8.73	Yes	39	952	63.5	12,498	7.60	48.73	15.59
3591	70.6	12.59	16.81	Yes	30	839	21.5	13,119	3.50	15.18	16.27
3598	74.73	12.68	12.59	Yes	40	1,102	75.5	33,069	8.25	56.42	14.62
3647	64.84	11.69	23.47	Yes	32	885	68	32,562	7.70	44.09	17.46
3696	64.09	13.79	22.12	Yes	36	840	62.5	44,029	11.50	40.05	28.71
3721	72.55	20.67	6.78	No.	19	1,143	75.5	32,523	7.60	54.77	13.88
3755	65.65	18.48	15.87	No.	33	885	52.5	6,550	5.50	34.47	15.96
3810	65.52	19.23	15.25	Yes	23	977	48.5	15,588	6.40	31.78	20.14

[a] 75.41 per cent of samples contained dodder.
[b] Total quantity of low-grade red clover seed imported, 990,809 pounds.

FIG. 1.—ALFALFA OF GOOD QUALITY.
Natural size and magnified 9 times.

FIG. 2.—IMPORTED ALFALFA OF LOW GRADE.
Natural size and magnified 9 times.

FIG. 3.—RED CLOVER OF GOOD QUALITY.
Natural size and magnified 9 times.

FIG. 4.—IMPORTED RED CLOVER OF LOW GRADE.
Natural size and magnified 9 times.

TABLE I.—*Analyses of 61 samples of low-grade red clover seed imported during the year ended June 30, 1906*—Continued.

Number of seed sample.	Red clover seed.	Other seeds.	Dirt and broken seed.	Dodder present.	Kinds of weed seeds.	Weight of 1,000 red clover seeds.	Germination of red clover seed.	Quantity imported.	Price per 100 pounds at which seed was imported.	Live red clover seed (seed that germinated) in sample.	Actual cost of 100 pounds of red clover seed that germinated.
	Per cent.	*Per cent.*	*Per cent.*		*Number.*	*Milligrams.*	*Per cent.*	*Pounds.*		*Per cent.*	
3811	57.3	22.81	19.89	Yes	45	1,021	42	15,506	$5.60	24.06	$23.27
3816	64.58	10.27	25.15	Yes	31	886	60.5	32,116	7.62	39.07	19.50
3834	77.45	7.70	14.85	Yes	28	1,087	66	33,159	9.60	51.12	18.78
3906	61.34	15.51	23.15	Yes	45	846	53	32,468	7.50	32.51	23.07
3945	67.04	17.10	15.86	Yes	36	891	67	12,474	8.50	44.91	18.93
3946	83.54	6.60	9.86	Yes	21	995	74	30,427	11.20	61.82	18.12
3959	94.04	.95	5.01	Yes	12	1,357	44.5	1,576	9.50	41.85	22.70
3960	94.15	1.77	4.08	Yes	19	1,552	69	11,288	9.90	64.96	15.24
3962	97.15	.66	2.19	Yes	11	1,538	34	12,000	8.60	33.03	26.04
3963	96.07	1.66	2.27	Yes	14	1,585	70	6,393	8.00	67.25	11.90
3964	96.32	1.93	1.75	Yes	11	1,603	72	5,952	9.10	69.35	13.12
3965	93.54	.27	6.19	Yes	9	1,422	15	2,425	4.50	14.03	32.07
3967	95.04	1.20	3.76	Yes	17	1,404	48	7,937	7.60	45.62	16.66
3994	47.49	32.08	20.43	Yes	41	909	17.5	10,995	4.70	8.31	56.56
3990	83.07	10.32	6.61	No	17	1,252	72.5	750	12.00	60.22	19.93
4009	83.87	8.02	8.31	Yes	42	1,370	46.5	11,130	8.20	38.9	21.08
4010	64.04	17.07	18.89	Yes	41	835	26	15,024	5.80	16.65	34.83
4026	68.59	17.78	13.63	Yes	20	870	86.5	4,000	14.20	59.33	23.93
4029	94.23	2.59	3.18	No	11	1,582	65.5	10,318	8.80	61.72	14.25
4031	95.41	1.76	2.83	Yes	11	1,495	54.5	2,500	8.98	51.99	17.27
4032	93.82	3.91	2.27	No	14	1,732	43.5	6,303	6.80	40.81	16.66
4035	95.52	2.16	2.32	Yes	19	1,555	27.5	3,382	7.80	26.27	29.69
4038	95.63	1.12	3.25	Yes	17	1,397	53.5	2,372	7.70	51.16	15.05
4044	67.80	14.91	17.29	Yes	43	963	31.5	32,074	7.00	21.36	32.77
4051	98.29	.41	1.3	No	5	1,597	59.5	2,551	6.90	58.48	11.79
4053	93.55	.17	6.28	Yes	8	1,434	8	1,102	4.50	7.48	60.16
4067	78.61	8.82	12.57	No	15	1,164	50	453	4.00	39.30	10.18
4084	61.09	16.93	21.98	No	19	1,236	75.5	33,866	10.10	46.12	21.90
4097	64.77	16.41	18.82	Yes	50	951	46	10,787	7.00	29.79	23.50
4118	74.04	15.18	10.78	Yes	35	1,010	60.5	2,963	7.50	44.79	16.74
4163	76.62	12.36	11.02	No	26	1,165	75.5	30,000	8.10	57.84	14.00
4165	54.44	24.57	20.99	No	37	868	38	18,200	6.00	20.68	29.01
4179	61.56	15.58	22.86	Yes	48	926	55.5	22,046	6.12	34.16	17.93
4180	61.04	12.58	26.38	Yes	27	926	75.5	4,851	7.70	46.08	16.71
4181	58.02	17.13	24.85	Yes	46	933	54	22,046	6.12	31.34	19.54
4183	77.65	8.15	14.20	Yes	38	980	87.5	7,363	9.75	67.94	14.35
4225	72.79	16.88	10.33	Yes	43	1,010	29	6,178	6.00	21.11	28.42
Average.	74.06	12.17	13.83		29.7	1,105.5	58.03	.....	7.61	43.16	20.39

In more than one-half of the sixty-one samples of which an analysis is given the weight of 1,000 seeds is less than a gram, while 1,000 good plump seeds weigh 1½ grams or more. These lots contain an average of only 43.1 per cent of live red clover seed and much of the seed that will germinate is worthless for seeding purposes, as it is of small size, immature, and of low vigor.

It is often claimed that seed of this kind is imported to be recleaned before it is put on the market. This, however, can not be the case, as in the importations referred to the average cost of the red clover seed that will grow is $20.39 per hundred pounds on the basis of the average import price of $7.61 per hundred pounds. At the time this seed was imported five lots of high-grade seed were offered for sale to the Department of Agriculture at an average price of $15.05 per hundred pounds, the average cost of the red clover seed that germinated being $15.59 per hundred pounds. In other words, one

hundred pounds of seed that would grow of the best quality cost $15.59, while one hundred pounds that would grow of the poorest quality was imported at a cost of $20.39.

This low-grade seed always carries a large number of weed seeds, fifty kinds being found in each of two lots. Of that from Germany all but five lots contained dodder seed.

In sowing seed of the average quality shown in Table I at the rate of 8 pounds to the acre there would be about nine weed seeds sown per square foot, including three dodder seeds to every 2 square feet.

Below is given the number of each kind of weed seeds found in the lots an analysis of which is given in Table I.

NUMBER OF WEED SEEDS TO THE POUND IN SIXTY-ONE SAMPLES OF LOW-GRADE RED CLOVER SEED IMPORTED DURING THE YEAR ENDED JUNE 30, 1906.

Sample No. 2945.—Black-seeded plantain, 95,580; lady's-thumb, 1,530; knotweed, 90; spurge, 1,440; mayweed, 450; catmint, 180; green foxtail, 4,320; yellow foxtail, 450; buckhorn, 1,890; bracted plantain, 540; chickweed, 270; curled dock, 1,260; bitter dock, 540; sorrel, 810; healall, 540; peppergrass, 360; wild carrot, 360; small crab-grass, 6,480; crab-grass, 5,670; slender paspalum, 1,350; pennyroyal, 2,700; stink-grass, 90; yellow trefoil, 540; five-finger, 180; barnyard grass, 90; spiny sida, 90; sedge, 90; three-seeded mercury, 270; vervain, 720; tumbling amaranth, 1,620; rough pigweed, 900; lamb's-quarters, 1,080; witch-grass, 7,470; spreading panicum, 990; prickly lettuce, 90; other weed seeds, 3,420.

Total weed seeds to the pound, 144,450.

Sample No. 2946.—Buckhorn, 16,200; clover dodder, 38,160; wild carrot, 5,256; healall, 4,608; low hop-clover, 648; plantain, 72; sorrel, 2,808; yellow trefoil, 144; wild chicory, 432; vervain, 432; field camomile, 360; mayweed, 72; woodrush, 72; mouse-ear chickweed, 72; lamb's-quarters, 72; hawkweed picris, 72; round-leaved toad-flax, 72; small-flowered crane's-bill, 216; bird's-foot trefoil, 72; other weed seeds, 1,728.

Total weed seeds to the pound, 71,568.

Sample No. 2947.—Buckhorn, 13,860; black-seeded plantain, 3,150; bracted plantain, 90; plantain, 90; yellow trefoil, 540; clover dodder, 3,600; Chilean clover dodder, 540; wild carrot, 3,060; sorrel, 1,350; curled dock, 270; vervain, 1,080; white vervain, 180; green foxtail, 810; lamb's-quarters, 810; healall, 630; bird's-foot trefoil, 360; hop-clover, 360; low hop-clover, 90; wild chicory, 270; kidney vetch, 90; witch-grass, 180; knotweed, 180; lady's-thumb, 90; small crab-grass, 90; ox-tongue, 90; spurry, 90; alfilaria, 90; other weed seeds, 810.

Total weed seeds to the pound, 32,850.

Sample No. 3101.—Green foxtail, 96,135; witch-grass, 1,020; plantain, 595; lamb's-quarters, 425; yellow trefoil, 595; small crab-grass, 255; lady's-thumb, 170; three-seeded mercury, 85; ragweed, 85; other weed seeds, 340.

Total weed seeds to the pound, 99,705.

Sample No. 3159.—Buckhorn, 24,130; Chilean clover dodder, 14,250; sorrel, 3,910; wild carrot, 3,910; healall, 3,825; yellow trefoil, 850; bird's-foot trefoil, 425; lamb's-quarters, 340; wild chicory, 340; ox-tongue, 340; green foxtail, 170; mayweed, 170; field camomile, 170; hop-clover, 170; mouse-ear chickweed, 85; small crab-grass, 85; low hop-clover, 170; chickweed, 85; kidney vetch, 85; red pimpernel, 85; small-flowered crane's-bill, 85; saltbush, 85; other weed seeds, 595.

Total weed seeds to the pound, 54,360.

Sample No. 3222.—Buckhorn, 93,678; clover dodder, 15,132; healall, 6,084; wild carrot, 3,276; sorrel, 2,652; yellow trefoil, 1,716; black-seeded plantain, 546; lamb's-quarters, 390; curled dock, 390; spurry, 390; bird's-foot trefoil, 312; vervain, 312; hop-clover, 234; saltbush, 156; lesser starwort, 156; mayweed, 156; white vervain, 78; chickweed, 78; ox-eye daisy, 78; green foxtail, 78; blue field madder, 78; peppergrass, 78; other weed seeds, 468.

Total weed seeds to the pound, 126,516.

Sample No. 3395.—Buckhorn, 13,940; clover dodder, 25,415; healall, 9,180; wild carrot, 5,015; sorrel, 5,490; yellow trefoil, 1,360; lamb's-quarters, 765; black-seeded plantain, 765; spurry, 425; hop-clover, 340; vervain, 255; curled dock, 255; rabbit's-foot clover, 170; wild chicory, 170; mayweed, 170; red pimpernel, 85; bird's-foot trefoil, 85; green foxtail, 85; other weed seeds, 595.

Total weed seeds to the pound, 64,565.

Sample No. 3400.—Buckhorn, 5,780; clover dodder, 8,364; sorrel, 7,790; healall, 4,592; yellow trefoil, 1,886; wild carrot, 1,558; lamb's-quarters, 656; field dodder, 410; red pimpernel, 328; hop-clover, 328; lesser starwort, 164; woodrush, 164; low hop-clover, 164; rabbit's-foot clover, 82; chickweed, 82; bitter dock, 82; small-seeded false flax, 82; vervain, 82; other weed seeds, 3,526.

Total weed seeds to the pound, 36,120.

Sample No. 3425.—Catchfly, 14,790; green foxtail, 5,780; sorrel, 4,674; buckhorn, 3,444; yellow trefoil, 3,198; curled dock, 3,280; plantain, 2,214; black-seeded plantain, 1,066; lamb's-quarters, 1,066; mayweed, 820; Canada thistle, 820; small crab-grass, 738; witch-grass, 410; mouse-ear chickweed, 410; lady's-thumb, 246; healall, 246; catmint, 164; evening primrose, 164; five-finger, 164; field cress, 164; stick-tight, 164; ragweed, 82; yellow foxtail, 164; chickweed, 82; other weed seeds, 492.

Total weed seeds to the pound, 44,842.

Sample No. 3432.—Buckhorn, 21,074; black-seeded plantain, 10,168; clover dodder, 11,316; wild carrot, 5,002; healall, 1,558; sorrel, 1,230; lamb's-quarters, 820; witch-grass, 656; yellow trefoil, 574; spreading panicum, 328; crab-grass, 410; small crab-grass, 492; chicory, 410; low hop-clover, 328; curled dock, 246; ragweed, 246; spurge, 164; mouse-ear chickweed, 164; bracted plantain, 82; forget-me-not, 82; catmint, 82; plantain, 82; barnyard grass, 82; five-finger, 82; small-seeded false flax, 82; Canada thistle, 82; red pimpernel, 246; hawkweed picris, 82; chickweed, 82; lesser starwort, 82; peppergrass, 82; bird's-foot trefoil, 82; scentless camomile, 82; other weed seeds, 1,558.

Total weed seeds to the pound, 58,138.

Sample No. 3456.—Buckhorn, 36,982; wild carrot, 36,326; yellow trefoil, 2,050; wild chicory, 4,264; clover dodder, 4,592; field dodder, 656; vervain, 2,542; healall, 1,968; low hop-clover, 82; sorrel, 984; curled dock, 410; hawkweed picris, 820; ox-tongue, 656; field camomile, 656; lamb's-quarters, 574; red pimpernel, 492; green foxtail, 410; black-seeded plantain, 164; lesser starwort, 164; Canada thistle, 82; nipplewort, 82; cat's-ear, 82; knotweed, 82; barnyard grass, 82; small crab-grass, 82; other weed seeds, 2,296.

Total weed seeds to the pound, 97,580.

Sample No. 3457.—Buckhorn, 35,700; wild carrot, 32,725; chicory, 4,845; clover dodder, 4,760; healall, 3,230; yellow trefoil, 1,785; sorrel, 1,105; lamb's-quarters, 850; green foxtail, 425; red pimpernel, 425; dodder, 425; field camomile, 340; ox-tongue, 340; curled dock, 340; hawkweed picris, 255; knotweed, 255; cut-leaved crane's-bill, 170; nipplewort, 170; black-seeded plantain, 170; mayweed, 85; lesser starwort, 85; bracted plantain, 85; spiny sow thistle, 85; other weed seeds, 5,015.

Total weed seeds to the pound, 93,070.

Sample No. 3488.—Buckhorn, 6,314; sorrel, 3,936; green foxtail, 3,198; curled dock, 2,050; lamb's-quarters, 1,640; black-seeded plantain, 1,476; plantain, 984; bitter dock, 820; catmint, 1,148; lesser starwort, 656; Canada thistle, 656; mouse-ear

chickweed, 574; mayweed, 902; lady's-thumb, 410; yellow trefoil, 328; small crab-grass, 246; stick-tight, 328; three-seeded mercury, 164; barnyard grass, 246; yellow foxtail, 164; knotweed, 82; healall, 82; witch-grass, 82; other weed seeds, 1,804.

Total weed seeds to the pound, 28,290.

Sample No. 3566.—Buckhorn, 19,890; clover dodder, 13,050; sorrel, 8,460; healall, 3,600; wild carrot, 3,420; yellow trefoil, 1,530; rabbit's-foot clover, 1,260; green foxtail, 990; low hop-clover, 630; black-seeded plantain, 450; spurry, 270; wild chicory, 270; hop-clover, 180; chickweed, 180; lesser starwort, 90; blue field madder, 90; Canada thistle, 90; small crab-grass, 90; mayweed, 90; field camomile, 90; other weed seeds, 6,300.

Total weed seeds to the pound, 61,020.

Sample No. 3571.—Green foxtail, 5,100; black-seeded plantain, 7,225; buckhorn, 3,910; plantain, 1,955; lamb's-quarters, 3,145; curled dock, 1,275; sorrel, 1,615; yellow trefoil, 2,805; witch-grass, 1,785; barnyard grass, 170; mayweed, 850; small crab-grass, 510; Canada thistle, 255; lady's-thumb, 170; mouse-ear chickweed, 170; small-seeded false flax, 85; catmint, 85; healall, 85; other weed seeds, 1,700.

Total weed seeds to the pound, 32,895.

Sample No. 3587.—Buckhorn, 23,322; wild carrot, 11,856; clover dodder, 14,742; healall, 3,042; sorrel, 2,028; lamb's-quarters, 1,560; yellow trefoil, 1,482; wild chicory, 1,248; plantain, 546; green foxtail, 468; rabbit's-foot clover, 390; low hop-clover, 312; curled dock, 312; mayweed, 234; red pimpernel, 234; evening primrose, 156; scentless camomile, 156; dove's-foot crane's-bill, 156; saltbush, 156; vervain, 3,198; small crab-grass, 156; five-finger, 156; field camomile, 156; lady's-thumb, 78; black-seeded plantain, 78; stick-tight, 78; kidney vetch, 78; frenchweed, 78; spurry, 78; ox-tongue, 78; witch-grass, 78; other weed seeds, 4,134.

Total weed seeds to the pound, 70,824.

Sample No. 3588.—Buckhorn, 24,055; dodder, 6,205; sorrel, 6,120; black-seeded plantain, 4,505; wild carrot, 2,720; healall, 2,805; lamb's-quarters, 1,615; yellow trefoil, 1,275; field camomile, 340; spurge, 510; small crab-grass, 595; low hop-clover, 425; green foxtail, 425; wild chicory, 340; bird's-foot trefoil, 340; crab-grass, 170; bracted plantain, 170; mayweed, 255; lady's-thumb, 170; lesser starwort, 85; yellow foxtail, 85; witch-grass, 85; five-finger, 85; spurry, 85; rabbit's-foot clover, 85; large-seeded false flax, 85; other weed seeds, 3,400.

Total weed seeds to the pound, 57,035.

Sample No. 3591.—Sorrel, 15,215; wild carrot, 10,710; lamb's-quarters, 9,945; buckhorn, 7,905; yellow trefoil, 4,565; healall, 2,975; catchfly, 2,295; curled dock, 2,040; black-seeded plantain, 1,785; green foxtail, 1,615; dodder, 850; kidney vetch, 510; saltbush, 425; red pimpernel, 340; small crab-grass, 340; slender paspalum, 255; wild chicory, 255; mayweed, 255; field camomile, 170; chickweed, 170; frenchweed, 170; spurry, 85; catmint, 85; lady's-thumb, 85; small-flowered crane's-bill, 85; other weed seeds, 1,020.

Total weed seeds to the pound, 64,150.

Sample No. 3598.—Sorrel, 56,706; buckhorn, 14,820; clover dodder, 18,876; wild carrot, 5,070; yellow trefoil, 2,106; healall, 1,326; lamb's-quarters, 624; green foxtail, 546; plantain, 468; wild chicory, 468; small crab-grass, 234; scentless camomile, 234; forget-me-not, 234; lesser starwort, 156; mouse-ear chickweed, 156; low hop-clover, 156; knotweed, 156; ox-eye daisy, 156; rabbit's-foot clover, 78; bird's-foot trefoil, 78; woodrush, 156; red pimpernel, 78; blue field madder, 78; cut-leaved crane's-bill, 78; saltbush, 78; field camomile, 312; other weed seeds, 1,092.

Total weed seeds to the pound, 104,520.

Sample No. 3647.—Buckhorn, 11,872; clover dodder, 25,424; sorrel, 6,608; healall, 4,592; wild carrot, 4,144; yellow trefoil, 2,352; lamb's-quarters, 784; vervain, 560; low hop-clover, 448; green foxtail, 336; small crab-grass, 336; lesser starwort, 336; red pimpernel, 336; chickweed, 224; spurry, 224; curled dock, 112; lady's-thumb, 112;

hop-clover, 112; mayweed, 112; field camomile, 112; small-seeded false flax, 112; other weed seeds, 3,584.

Total weed seeds to the pound, 62,832.

Sample No. 3696.—Yellow trefoil, 2,542; clover dodder, 29,520; buckhorn, 12,218; wild carrot, 8,528; low hop-clover, 984; hop-clover, 410; healall, 5,330; sorrel, 7,626; curled dock, 164; lamb's-quarters, 2,132; vervain, 1,066; red pimpernel, 574; lesser starwort, 574; green foxtail, 574; mayweed, 246; field camomile, 246; wild chicory, 164; kidney vetch, 164; bird's-foot trefoil, 164; spurry, 164; barnyard grass, 82; small crab-grass, 82; blue field madder, 82; wood rush, 82; other weed seeds, 3,444.

Total weed seeds to the pound, 77,162.

Sample No. 3721.—Buckhorn, 7,735; green foxtail, 4,250; sorrel, 2,380; curled dock, 2,210; lamb's-quarters, 1,615; plantain, 1,445; bitter dock, 1,275; black-seeded plantain, 850; yellow trefoil, 765; catmint, 595; Canada thistle, 425; lady's-thumb, 340; mouse-ear chickweed, 255; small crab-grass, 255; knotweed, 170; mayweed, 170; other weed seeds, 2,125.

Total weed seeds to the pound, 26,860.

Sample No. 3755.—Green foxtail, 3,740; buckhorn, 3,400; black-seeded plantain, 2,720; sorrel, 2,720; lamb's-quarters, 3,125; catmint, 1,700; curled dock, 1,615; Canada thistle, 1,190; black-seeded plantain, 1,275; yellow trefoil, 595; lady's-thumb, 510; witch-grass, 340; barnyard grass, 340; lesser starwort, 255; mouse-ear chickweed, 255; mayweed, 255; small crab-grass, 255; ragweed, 255; stick-tight, 170; ox-eye daisy, 170; chickweed, 85; wild chicory, 85; yellow foxtail, 85; three-seeded mercury, 85; small-seeded false flax, 85; other weed seeds, 2,890.

Total weed seeds to the pound, 27,200.

Sample No. 3810.—Buckhorn, 7,020; dodder, 6,930; lamb's-quarters, 4,950; green foxtail, 3,420; healall, 2,790; sorrel, 3,060; wild carrot, 2,430; yellow trefoil, 810; saltbush, 1,080; red pimpernel, 900; mayweed, 270; field camomile, 180; vervain, 90; wild chicory, 90; low hop-clover, 90; rabbit's-foot clover, 90; hop-clover, 90; bird's-foot trefoil, 90; lesser starwort, 90; sweet clover, 90; other weed seeds, 1,980.

Total weed seeds to the pound, 36,540.

Sample No. 3811.—Clover dodder, 18,700; buckhorn, 19,380; lamb's-quarters, 5,355; green foxtail, 4,080; sorrel, 3,315; wild carrot, 3,060; healall, 2,550; yellow trefoil, 1,360; saltbush, 1,190; wild chicory, 680; red pimpernel, 425; rabbit's-foot clover, 340; white campion, 170; ox-tongue, 170; hawkweed picris, 85; early winter cress, 170; Canada thistle, 85; mayweed, 85; field camomile, 85; bitter dock, 85; curled dock, 85; lady's-thumb, 85; knotweed, 85; kidney vetch, 85; chickweed, 85; sweet clover, 85; black-seeded plantain, 85; mallow, 85; spurry, 85; stick-tight, 85; blue field madder, 85; other weed seeds, 2,635.

Total weed seeds to the pound, 64,940.

Sample No. 3816.—Buckhorn, 13,104; clover dodder, 6,240; wild carrot, 5,304; sorrel, 4,914; healall, 4,758; yellow trefoil, 2,574; lamb's-quarters, 1,170; green foxtail, 546; kidney vetch, 468; low hop-clover, 312; round-leaf toad flax, 234; curled dock, 234; lesser starwort, 234; chickweed, 78; ox-tongue, 156; black-seeded plantain, 156; plantain, 78; forget-me-not, 78; wood rush, 78; small crab-grass, 78; bull thistle, 78; bird's-foot trefoil, 78; other weed seeds, 3,900.

Total weed seeds to the pound, 44,850.

Sample No. 3834.—Clover dodder, 7,055; field dodder, 680; buckhorn, 7,820; sorrel, 6,205; healall, 4,420; wild carrot, 2,975; lamb's-quarters, 2,125; yellow trefoil, 1,190; green foxtail, 425; curled dock, 255; rabbit's-foot clover, 170; bird's-foot trefoil, 170; small-flowered crane's-bill, 170; chickweed, 170; yellow foxtail, 85; black-seeded plantain, 85; ox-tongue, 85; forget-me-not, 85; other weed seeds, 3,145.

Total weed seeds to the pound, 37,315.

Sample No. 3906.—Buckhorn, 14,305; clover dodder, 28,475; sorrel, 6,375; wild carrot, 6,375; healall, 6,375; lamb's-quarters, 3,145; yellow trefoil, 3,060; green fox-

tail, 2,295; black-seeded plantain, 1,275; low hop-clover, 935; rabbit's-foot clover, 850; red pimpernel, 680; curled dock, 680; mayweed, 425; bird's-foot trefoil, 340; kidney vetch, 340; hop-clover, 255; witch-grass, 170; ox-tongue, 170; lesser starwort, 170; round-leaved toad flax, 170; small-flowered crane's-bill, 85; ragweed, 85; spurry, 85; small crab-grass, 85; lady's-thumb, 85; sweet clover, 85; nipplewort, 85; other weed seeds, 4,845.

Total weed seeds to the pound, 82,305.

Sample No. 3945.—Buckhorn, 22,050; clover dodder, 6,570; healall, 3,960; green foxtail, 2,430; wild carrot, 2,430; lamb's-quarters, 2,340; yellow trefoil, 1,980; sorrel, 1,350; bird's-foot trefoil, 540; red pimpernel, 540; ox-tongue, 90; vervain, 270; small crab-grass, 180; low hop-clover, 90; lady's-thumb, 90; slender paspalum, 90; curled dock, 90; wild chicory, 90; field camomile, 90; hawkweed picris, 90; mayweed, 90; hop-clover, 90; other weed seeds, 2,430.

Total weed seeds to the pound, 47,970.

Sample No. 3946.—Buckhorn, 14,400; yellow trefoil, 3,570; healall, 1,615; clover dodder, 1,445; kidney vetch, 935; green foxtail, 850; lamb's-quarters, 1,020; sorrel, 850; wild carrot, 255; rabbit's-foot clover, 170; bird's-foot trefoil, 170; round-leaved toad flax, 85; ox-tongue, 85; bur clover, 85; small-flowered crane's-bill, 85; other weed seeds, 1,020.

Total weed seeds to the pound, 26,640.

Sample No. 3959.—Sorrel, 680; lamb's-quarters, 425; sweet clover, 425; green foxtail, 85; wild carrot, 85; yellow trefoil, 85; dodder, 85; lesser starwort, 85; rabbit's-foot clover, 85; other weed seeds, 595.

Total weed seeds to the pound, 2,635.

Sample No. 3960.—Buckhorn, 1,700; lamb's-quarters, 1,190; clover dodder, 850; yellow trefoil, 595; low hop-clover, 510; wild carrot, 340; green foxtail, 340; yellow foxtail, 255; blueweed, 170; rabbit's-foot clover, 170; sorrel, 170; healall, 85; sweet clover, 85; field camomile, 85; scentless camomile, 85; small-seeded false flax, 85; other weed seeds, 425.

Total weed seeds to the pound, 7,140.

Sample No. 3962.—Dodder, 1,190; buckhorn, 425; lamb's-quarters, 255; sweet clover, 510; low hop-clover, 85; curled dock, 85; yellow trefoil, 85; blueweed, 85; kidney vetch, 85; other weed seeds, 510.

Total weed seeds to the pound, 3,315.

Sample No. 3963.—Buckhorn, 2,028; wild carrot, 546; sorrel, 390; clover dodder, 936; field camomile, 156; yellow foxtail, 78; wild chicory, 78; healall, 78; lamb's-quarters, 390; other weed seeds, 702.

Total weed seeds to the pound, 5,382.

Sample No. 3964.—Buckhorn, 3,690; sorrel, 1,722; clover dodder, 1,066; lamb's-quarters, 246; lesser starwort, 82; yellow foxtail, 82; healall, 82; forget-me-not, 82; other weed seeds, 574.

Total weed seeds to the pound, 7,626.

Sample No. 3965.—Low hop-clover, 170; lamb's-quarters, 170; buckhorn, 85; healall, 85; wild carrot, 85; forget-me-not, 85; blueweed, 85; dodder, 85; chickweed, 85.

Total weed seeds to the pound, 935.

Sample No. 3967.—Lamb's-quarters, 1,615; buckhorn, 1,020; dodder, 850; yellow trefoil, 340; wild carrot, 255; sweet clover, 170; rabbit's-foot clover, 170; forget-me-not, 85; red pimpernel, 85; field camomile, 85; sorrel, 85; other weed seeds, 850.

Total weed seeds to the pound, 5,610.

Sample No. 3990.—Green foxtail, 20,060; curled dock, 4,590; bitter dock, 170; lamb's-quarters, 5,440; buckhorn, 680; yellow trefoil, 850; lady's-thumb, 425; sticktight, 255; sorrel, 170; mayweed, 170; Canada thistle, 170; ragweed, 170; barnyard grass, 85; other weed seeds, 850.

Total weed seeds to the pound, 34,085.

Sample No. 3994.—Plantain, 26,814; mouse-ear chickweed, 12,300; five-finger, 3,608; buckhorn, 2,788; lamb's-quarters, 3,115; sorrel, 2,378; curled dock, 2,132; shepherd's-purse, 1,804; black-seeded plantain, 1,722; mayweed, 1,722; small crab-grass, 738; yellow trefoil, 656; lady's-thumb, 492; stick-tight, 410; witch-grass, 410; wormseed mustard, 328; peppergrass, 328; barnyard grass, 246; yellow foxtail, 82; evening primrose, 82; spiny sow thistle, 82; sedge, 82; catmint, 82; clover dodder, 82; knotweed, 82; three-seeded mercury, 82; green foxtail, 5,740; Canada thistle, 904; small-seeded false flax, 82; clover dodder, 82; other weed seeds, 4,018.

Total weed seeds to the pound, 73,473.

Sample No. 4009.—Buckhorn, 12,948; wild chicory, 1,968; yellow trefoil, 2,460; wild carrot, 1,640; hop-clover, 82; rabbit's-foot clover, 82; clover dodder, 820; Chilean clover dodder, 164; green foxtail, 984; yellow foxtail, 246; healall, 820; saltbush, 738; lamb's-quarters, 656; kidney vetch, 492; black-seeded plantain, 82; bracted plantain, 82; plantain, 82; barnyard grass, 328; sorrel, 410; curled dock, 328; knotweed, 246; field camomile, 246; mayweed, 82; sweet clover, 164; ragweed, 164; red pimpernel, 164; Canada thistle, 82; cut-leaved crane's-bill, 82; bird's-foot trefoil, 82; nipplewort, 82; sticktight, 82; other weed seeds, 2,788.

Total weed seeds to the pound, 29,676.

Sample No. 4010.—Buckhorn, 23,375; sorrel, 11,730; clover dodder, 11,815; healall, 6,460; yellow trefoil, 4,675; lamb's-quarters, 2,465; wild carrot, 1,105; red pimpernel, 1,190; low hop-clover, 1,105; rabbit's-foot clover, 1,105; mouse-ear chickweed, 1,360; lesser starwort, 935; hop-clover, 935; vervain, 850; chickweed, 255; spurry, 255; kidney vetch, 255; green foxtail, 255; mayweed, 170; field camomile, 85; forget-me-not, 85; small-flowered crane's-bill, 85; bur clover, 85; black-seeded plantain, 85; plantain, 85; other weed seeds, 8,330.

Total weed seeds to the pound, 79,135.

Sample No. 4026.—Buckhorn, 60,210; green foxtail, 6,390; ox-tongue, 6,930; wild carrot, 5,950; clover dodder, 3,570; yellow trefoil, 3,315; red pimpernel, 2,040; healall, 1,955; bird's-foot trefoil, 1,785; ox-tongue, 1,445; round-leaved toad flax, 1,190; wild chicory, 340; hawkweed picris, 255; mayweed, 85; other weed seeds, 1,275.

Total weed seeds to the pound 96,735.

Sample No. 4029.—Yellow trefoil, 5,220; buckhorn, 1,615; sorrel, 1,360; lamb's-quarters, 595; healall, 85; yellow foxtail, 85; other weed seeds, 510.

Total weed seeds to the pound, 9,470.

Sample No. 4031.—Clover dodder, 11,730; sorrel, 765; lamb's-quarters, 680; wild carrot, 595; healall, 510; black-seeded plantain, 255; buckhorn, 255; curled dock, 85; five-finger, 85; other weed seeds, 170.

Total weed seeds to the pound, 15,130.

Sample No. 4032.—Lamb's-quarters, 20,418; lady's-thumb, 410; cleavers, 656; curled dock, 410; saltbush, 246; stick-tight, 246; small-seeded false flax, 164; yellow trefoil, 164; sorrel, 82; other weed seeds, 574.

Total weed seeds to the pound, 23,370.

Sample No. 4035.—Lamb's-quarters, 5,304; buckhorn, 936; clover dodder, 780; sorrel, 546; rabbit's-foot clover, 156; yellow trefoil, 234; wild carrot, 156; blueweed, 156; green foxtail, 78; spurry, 78; bird's-foot trefoil, 78; other weed seeds, 3,822.

Total weed seeds to the pound, 12,324.

Sample No. 4038.—Clover dodder, 1,170; lamb's-quarters, 2,880; wild carrot, 360; scentless camomile, 270; wild chicory, 180; mayweed, 90; healall, 90; red pimpernel, 90; plantain, 90; sorrel, 90; hop-clover, 90; other weed seeds, 540.

Total weed seeds to the pound, 5,940.

Sample No. 4044.—Buckhorn, 12,710; clover dodder, 18,204; wild carrot, 6,630; sorrel, 2,865; healall, 3,910; yellow trefoil, 3,230; lamb's-quarters, 2,465; green foxtail, 1,615; curled dock, 1,530; round-leaved toad flax, 1,105; red pimpernel, 1,020; black-seeded plantain, 680; hop-clover, 595; low hop-clover, 510; spurry, 340; lesser star-

wort, 340; mayweed, 255; field camomile, 170; small crab-grass, 170; kidney vetch, 255; yellow foxtail, 85, stick-tight, 85; wild chicory, 85; lady's-thumb, 85; ox-tongue, 85; chickweed, 85; other weed seeds, 5,100.

Total weed seeds to the pound, 64,209.

Sample No. 4051.—Sorrel, 2,720; lamb's-quarters, 340; rabbit's-foot clover, 340; black-seeded plantain, 255; knotweed, 85.

Total weed seeds to the pound, 3,740.

Sample No. 4053.—Low hop-clover, 85; buckhorn, 170; field camomile, 170; clover dodder, 85; healall, 85; other weed seeds, 425.

Total weed seeds to the pound, 1,020.

Sample No. 4067.—Buckhorn, 15,030; green foxtail, 8,100; black-seeded plantain, 7,650; barnyard grass, 630; yellow foxtail, 540; three-seeded mercury, 540; knotweed, 270; lady's-thumb, 270; plantain, 270; five-finger, 180; yellow trefoil, 90; lamb's-quarters, 90; curled dock, 90; witch-grass, 90; other weed seeds, 360.

Total weed seeds to the pound, 34,200.

Sample No. 4084.—Lady's-thumb, 10,030; plantain, 20,740; mouse-ear chickweed, 17,000; curled dock, 3,230; shepherd's-purse, 2,975; yellow trefoil, 1,785; lamb's-quarters, 1,700; five-finger, 1,615; green foxtail, 935; black-seeded plantain, 850; Canada thistle, 680; spiny sow thistle, 255; yellow foxtail, 170; knotweed, 85; other weed seeds, 340.

Total weed seeds to the pound, 62,390.

Sample No. 4097.—Buckhorn, 16,405; clover dodder, 24,820; wild carrot, 6,290; sorrel, 6,205; healall, 6,035; yellow trefoil, 3,910; green foxtail, 3,485; lamb's-quarters, 3,400; kidney vetch, 1,020; vervain, 935; red pimpernel, 850; black-seeded plantain, 595; low hop-clover, 510; mayweed, 510; curled dock, 510; rabbit's-foot clover, 425; lesser starwort, 240; ox-tongue, 255; saltbush, 255; field camomile, 170; wild chicory, 170; lady's-thumb, 170; small crab-grass, 170; blue field madder, 85; slender paspalum 85; ragweed, 85; small-flowered crane's-bill, 85; hedge mustard, 85; hop-clover, 85; sweet clover, 85; other weed seeds, 7,395.

Total weed seeds to the pound, 85,325.

Sample No. 4118.—Yellow trefoil, 20,790; buckhorn, 20,610; healall, 3,510; wild carrot, 3,150; clover dodder, 2,970; sorrel, 2,160; catchfly, 1,080; lamb's-quarters, 990; field camomile, 900; red pimpernel, 540; kidney vetch, 270; green foxtail, 180; scentless camomile, 180; chickweed, 180; small-flowered crane's-bill, 180; Canada thistle, 90; wild chicory, 90; lady's-thumb, 90; lesser starwort, 90; cut-leaved crane's-bill, 90; blue field madder, 90; field dodder, 90; other weed seeds, 1,980.

Total weed seeds to the pound, 60,300.

Sample No. 4163.—Buckhorn, 4,410; plantain, 3,825; green foxtail, 3,655; mayweed, 1,870; black-seeded plantain, 1,530; curled dock, 765; five-finger, 425; catmint, 340; sorrel, 340; lady's-thumb, 340; Canada thistle, 340; ragweed, 255; mouse-ear chickweed, 170; barnyard grass, 170; yellow trefoil, 170; wild basil, 170; yellow foxtail, 85; wormseed mustard, 85; small crab-grass, 85; other weed seeds, 2,635.

Total weed seeds to the pound, 21,665.

Sample No. 4165.—Black-seeded plantain, 93,585; green foxtail, 6,035; small crab-grass, 7,055; crab-grass, 4,760; witch-grass, 4,845; buckhorn, 2,720; curled dock, 2,380; lady's-thumb, 1,785; pennyroyal, 1,445; lamb's-quarters, 1,360; bracted plantain, 1,445; spurge, 1,275; yellow foxtail, 1,105; spreading panicum, 595; sorrel, 850; peppergrass, 340; evening primrose, 255; mayweed, 255; yellow trefoil, 255; slender paspalum, 170; barnyard grass, 170; spiny sida, 170; wild carrot, 170; catmint, 85; three-seeded mercury, 85; other weed seeds, 4,080.

Total weed seeds to the pound, 137,275.

Sample No. 4179.—Buckhorn, 20,202; clover dodder, 35,802; wild carrot, 5,772; lamb's-quarters, 5,070; sorrel, 5,070; yellow trefoil, 2,886; healall, 3,822; low hop-clover, 1,092; green foxtail, 1,014; red pimpernel, 624; dodder, 468; vervain, 546;

rabbit's-foot clover, 468; oxtongue, 390; hop-clover, 312; curled dock, 234; saltbush, 234; field camomile, 234; mayweed, 156; wild chicory, 156; black-seeded plantain, 156; nettle-leaved goosefoot, 78; forget-me-not, 78; mouse-ear chickweed, 78; lady's-thumb, 78; scentless camomile, 312; plantain, 78; chickweed, 78; lesser starwort, 234; kidney vetch, 78; other weed seeds, 3,822.

Total weed seeds to the pound, 91,422.

Sample No. 4180.—Buckhorn, 27,716; clover dodder, 35,670; low hop-clover, 1,445; rabbit's-foot clover, 255; wild carrot, 3,400; sorrel, 3,485; yellow trefoil, 3,145; healall, 2,890; lamb's-quarters, 2,720; field camomile, 765; red pimpernel, 595; green foxtail, 510; wild chicory, 425; lesser starwort, 340; chickweed, 85; nipplewort, 85; Canada thistle, 85; forget-me-not, 85; small-flowered crane's-bill, 85; bird's-foot trefoil, 85; small-seeded false flax, 85; other weed seeds, 3,145.

Total weed seeds to the pound, 77,101.

Sample No. 4181.—Buckhorn, 21,690; clover dodder, 46,980; sorrel, 7,565; wild carrot, 5,780; lamb's-quarters, 4,760; healall, 4,335; yellow trefoil, 2,465; green foxtail, 1,360; lesser starwort, 935; red pimpernel, 850; scentless camomile, 765; low hop-clover, 765; round-leaved toad flax, 595; rabbit's-foot clover, 510; black-seeded plantain, 595; field camomile, 340; kidney vetch, 340; wild chicory, 340; spurry, 255; chickweed, 170; ox-tongue, 170; forget-me-not, 170; saltbush, 170; hop-clover, 170; ox-eye daisy, 170; yarrow, 85; plantain, 85; mayweed, 85; curled dock, 85; other weed seeds, 5,440.

Total weed seeds to the pound, 90,025.

Sample No. 4183.—Buckhorn, 9,540; clover dodder, 8,460; lamb's-quarters, 6,210; green foxtail, 4,320; oxtongue, 1,710; round-leaved toad flax, 1,800; yellow trefoil, 1,260; red pimpernel, 900; low hop-clover, 810; wild carrot, 540; sorrel, 360; hawkweed picris, 360; healall, 180; large-seeded false flax, 180; mayweed, 180; forget-me-not, 180; rabbit's-foot clover, 90; spurry, 90; witch-grass, 90; field camomile, 90; small-seeded false flax, 90; field cress, 90; horehound, 90; Frenchweed, 90; bull thistle, 90; other weed seeds, 3,510.

Total weed seeds to the pound, 41,310.

Sample No. 4225.—Buckhorn, 26,910; Chilean dodder, 5,940; wild carrot, 9,360; sorrel, 7,560; catchfly, 7,380; healall, 6,390; clover dodder, 6,210; lamb's-quarters, 3,600; yellow trefoil, 2,610; small-flowered crane's-bill, 900; lesser starwort, 810; red pimpernel, 630; green foxtail, 630; spurry, 540; mayweed, 540; small crab-grass, 450; kidney vetch, 360; bird's-foot trefoil, 270; plantain, 270; blue field madder, 180; forget-me-not, 180; yellow foxtail, 180; oxeye daisy, 90; scentless camomile, 90; curled dock, 90; spurge, 90; slender paspalum, 90; chickweed, 90; hop clover, 90; low hop-clover, 90; other weed seeds, 5,760.

Total weed seeds to the pound, 88,380.

In Table II are given the analyses of the five samples of high-grade red clover offered for sale at an average price of $15.05 per hundred pounds, previously referred to.

TABLE II.—*Analyses of five samples of high-grade red clover seed offered for sale during the year ended June 30, 1906.*

Number of seed sample.	Red clover seed.	Other seeds.	Dirt and broken seed.	Dodder present.	Kinds of weed seeds.	Weight of 1,000 red clover seeds.	Germination of red clover seed.	Price per 100 pounds at which seed was offered for sale.	Live red clover seed (seed that germinated) in sample.	Actual cost of 100 pounds of red clover seed that germinated.
	Per cent.	*Per cent.*	*Per cent.*		*Number.*	*Milligrams.*	*Per cent.*		*Per cent.*	
36668	96.59	1.44	1.97	No	7	1,705	100	$15.00	96.59	$15.53
37427	98.54	.28	1.18	No	2	1,501	98.5	14.00	97.06	14.42
37440	98.42	.93	.65	No	7	1,531	97.5	14.75	95.96	15.37
37442	97.00	1.27	1.73	No	7	1,678	100	16.00	97.00	16.49
37443	98.10	.35	1.55	No	3	1,486	98	15.50	96.14	16.12
Average	97.73	.85	1.42		5.2	1,580	98.8	15.05	96.55	15.58

The accompanying diagram presents in graphic form a comparison of the averages of the analyses of red clover seed imported, as shown in Tables I and II.

ALFALFA.

Table III gives the analyses of sixteen selected low-grade samples of imported alfalfa seed, representing cargoes amounting to 275,572 pounds. Since the total importations of alfalfa seed during the same period were 5,688,689 pounds, the low-grade seed furnished about one-twentieth of the total. The quality of this low-grade seed is similar to that of the red clover seed shown in Table I. The germination is low and the seed in many samples is small or shriveled. All but two of these lots contain dodder, and all contained on an average more than fifteen kinds of weed seeds.

TABLE III.—*Analyses of sixteen samples of low-grade alfalfa seed imported during the fiscal year ended June 30, 1906.*

Number of seed sample.	Alfalfa seed.	Other seeds.	Dirt and broken seed.	Dodder present.[a]	Kinds of weed seeds.	Weight of 1,000 alfalfa seeds.	Germination of alfalfa seed.	Quantity of seed imported.[b]	Price per 100 pounds at which seed was imported.	Live alfalfa seed (seed that germinated) in sample.	Actual cost of 100 pounds of alfalfa seed that germinated.
	Per cent.	*Per cent.*	*Per cent.*		*Number.*	*Milligrams.*	*Per cent.*	*Pounds*		*Per cent.*	
2929	84.56	3.52	11.92	Yes	18	1,704	79.5	10,208	$9.50	67.22	$14.13
2941	96.18	1.28	2.54	No	1	2,166	46	12,106	8.10	44.24	18.30
2942	88.58	1.98	9.44	Yes	14	1,890	53	7,797	7.90	46.95	16.83
2996	89.42	3.68	6.9	No	10	1,787	56.5	16,475	9.25	50.52	18.31
3002	88.06	3.24	8.7	No	12	1,866	52.5	32,439	9.40	46.23	20.33
3003	87.8	3.54	8.66	No	12	1,748	45	15,923	9.90	39.5	25.06
3047	90.46	3.97	5.57	Yes	14	1,757	58	16,610	10.25	52.47	19.53
3068	94.38	2.59	3.03	Yes	9	1,834	50	14,475	8.50	47.19	18.01
3082	91.01	4.33	4.66	Yes	15	1,622	63.5	16,632	10.25	57.79	17.73
3158	90.8	4.68	4.52	Yes	18	1,328	9	33,275	2.00	8.17	22.22
3393	94.63	1.77	3.6	Yes	17	1,753	73.5	16,500	10.13	69.55	14.56
3751	87.4	2.1	10.5	Yes	20	1,529	8	33,022	2.63	6.99	37.55
4132	82.02	6.18	11.8	Yes	23	1,032	77	5,610	7.50	63.15	11.87
4135	72.54	14.13	13.33	Yes	22	1,065	50	11,396	6.00	36.27	16.54
4232	63.85	16.79	19.36	Yes	26	1,037	58.5	3,844	5.00	37.35	13.39
4267	81.31	4.38	14.31	Yes	21	1,164	43.5	29,261	5.70	35.37	16.12
Average	86.44	4.89	8.68		15.75	1,580	51.47		7.43	44.31	18.78

[a] 75 per cent of the samples contained dodder.
[b] Total quantity of low-grade alfalfa seed imported, 275,572 pounds.

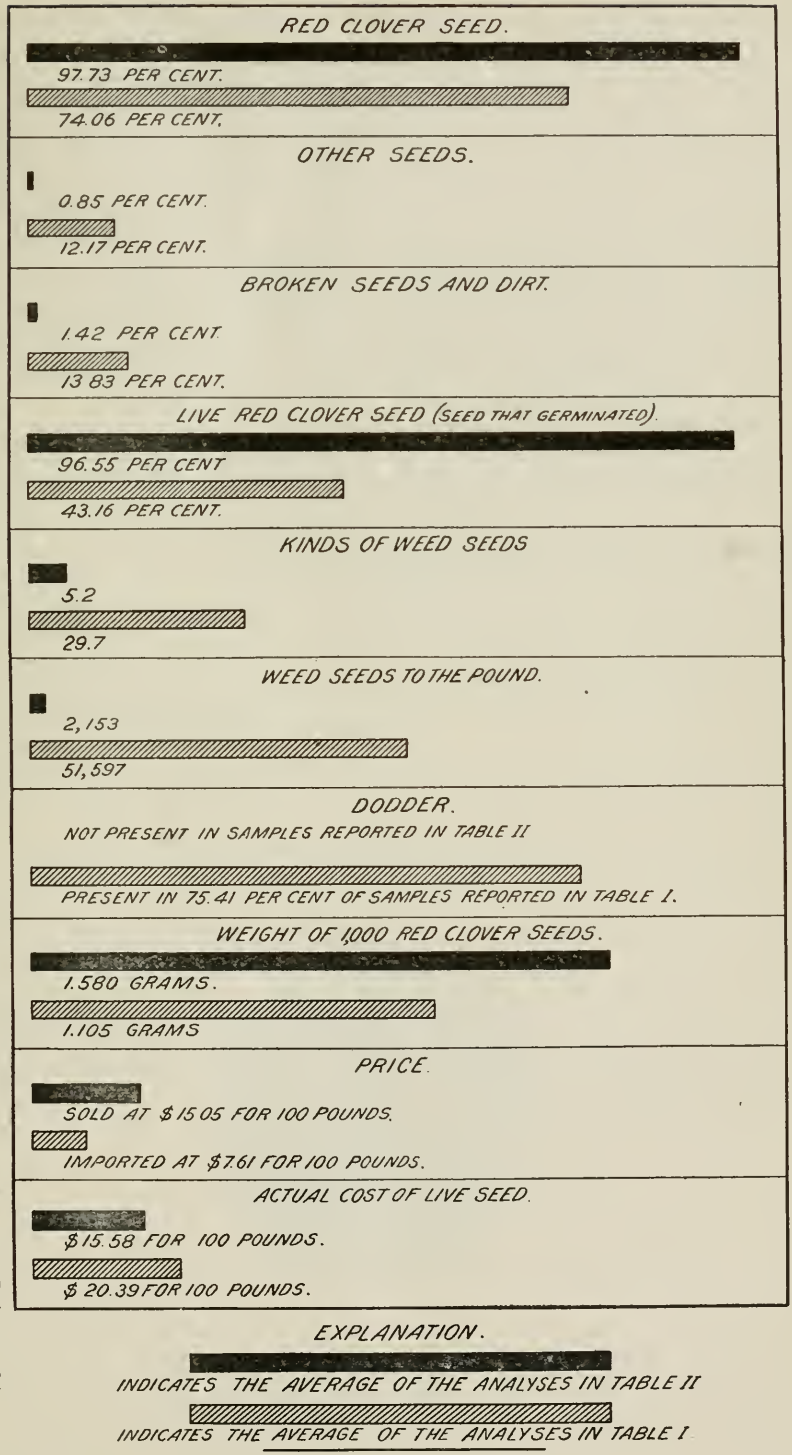

FIG. I.—High-grade red clover seed compared with low-grade red clover seed: Averages of analyses shown in Table II (high-grade) and Table I (low-grade).

THE IMPORTATION OF LOW-GRADE SEED SHOULD BE STOPPED.

Every pound of worthless seed imported is finally sold to the farmer. Some of it goes into the trade to fill the demand for cheap seed. More of it is used to mix with better seed in the grading-down process. By mixing 100 pounds of seed worth $15 with 100 pounds of imported screenings which cost $7.50, a medium grade will result, costing $11.25 per hundred pounds, which is not sold at $11.25 but at $13 or $14 per hundred pounds. Whenever a dealer mixes two qualities of seed together to make a medium or low grade the price is not reduced in proportion to the quality. In this way the jobber or dealer who mixes seeds invariably gets a profit on the screenings which are used.

Unfortunately many farmers in the United States furnish a ready market for the refuse from our own cleaning mills, and moreover, on account of their demand for cheap seed, we are importing the waste from other countries. Seedsmen should not, perhaps, be altogether blamed for meeting this demand for cheap seed, and they must be expected to sell it as long as there is a call for it. At the same time, the farmer not being as good a judge as the seedsman often takes what is offered at the lowest price and unwittingly pays more for the seed that will grow than if he had bought the best. What is of more importance to the farmer, however, is not that he is paying more for his seed than he should, but that in buying low-grade seed he gets either a poor stand from sowing dead seed, or small, weak plants from sowing seed of low vigor, or the crop is smothered by weeds which will continue to foul the land for many years.

Argentina has a law prohibiting the importation of alfalfa and clover seed containing the seed of dodder. Canada prohibits the sale within her borders of seed containing weed seeds, but provides for its export. Europe is effectually protected from the use of poor seeds through its seed-control stations, but its screenings are exported. It seems time that the United States had some restriction on the importation of seeds of such poor quality that they can not be sold in other countries.

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B. T. GALLOWAY, *Chief of Bureau.*

FORAGE CROPS FOR HOGS IN KANSAS AND OKLAHOMA.

BY

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FORAGE CROPS FOR HOGS IN KANSAS AND OKLAHOMA.

INTRODUCTION.

Farmers are more and more realizing that pasture is necessary for the most economical production of pork. Those who are raising hogs and putting them on the market with the least cost have their entire farms fenced hog tight. This enables them to give the hogs the range of the meadows and fields when the crops have been harvested. Much that would otherwise be lost is thus saved by the hogs, for they are among the best gleaners of the waste grain, weeds, and insects in the fields.

More hog pastures are fenced each year, more experimenting is being done, and there is more inquiry as to the best crops for pasture. These questions can not be answered intelligently without a knowledge of the conditions of soil and climate, the market, and the adaptability of crops to different sections of the country.

The Office of Farm Management Investigations has undertaken to ascertain by a study of farm practice: (1) What crops have been found best for pasture for hogs in different localities; (2) the season during which these crops are available; (3) the number of stock they will pasture to the acre; (4) the value of this pasture in connection with other feeds; (5) the quantity of grain necessary to produce a given amount of pork on different pastures; and (6) the cost of producing pork.

While only a small beginning has been made, the demand for such knowledge and its importance to the swine industry of the country has prompted the publishing of this information for each locality as it is obtained.

CROPS USED IN KANSAS AND OKLAHOMA.

During the past summer (1907) about 150 of the most successful swine growers and pork producers of Kansas and Oklahoma were interviewed on the subject of the crops used for feed. In southern

Oklahoma along the river valleys and in northern Oklahoma and southern Kansas the farmers are favored with a soil and climate that make it possible to produce pork very cheaply. The mildness of the climate makes it unnecessary to build as expensive shelters for hogs in winter as are required farther north, and the open and short winters make it possible to furnish pasture during a greater portion of the year, thus lessening the amount of grain which it is necessary to feed. The main pasture crops for hogs in this region are alfalfa, wheat, oats, and rye, ranking in importance in the order named.

ALFALFA.

It is the testimony of 95 per cent of the farmers interviewed in this region that there is no better pasture for hogs than alfalfa, where it can be grown successfully. Those who have failed with it as pasture owe their failure to two causes. First, the alfalfa has been pastured before it has become well rooted. Young alfalfa is too tender a plant to stand severe treatment except under very favorable circumstances. There are a few farmers who have pastured it the same year it was sown and the alfalfa has survived, but this was on rich, heavy loam soil, usually creek bottom or river valley land with water not far below the surface, and the season was very favorable. Ordinarily alfalfa should not be pastured until the second year, and better still not until the third year if it is desired to keep the field as permanent pasture.

The second cause of failure with alfalfa is heavy pasturing and lack of judgment in pasturing in unfavorable seasons. A good many farmers have sown a small piece of alfalfa, and then because it has grown rapidly and all kinds of stock are fond of it they have turned all the stock on the farm on it and have wondered why their alfalfa was killed out. Others pasture regardless of whether the ground is muddy or whether the season is dry and hot. In either case heavy pasturing is very likely to cause the alfalfa to be killed out.

ALFALFA PASTURES.

As to the amount of pasturage or the number of hogs alfalfa will carry per acre without injury to the crop, the estimates given by farmers vary considerably, depending on the kind of soil, the fertility of the land, and the size of the hogs pastured. The following, however, is a safe average estimate as given by conservative men who have had much experience. River valley and creek bottom land well set in alfalfa will carry from 15 to 20 head per acre of 50 to 125

pound hogs. Upland of fair average fertility will support from 8 to 10 head of the same kind of hogs. There are fields that have supported 25 head per acre all through the season for a number of years and are still in good condition, and there are other fields that will not furnish pasture for more than 5 head per acre; but these are extremes. When a field is used only for pasture it is better to divide it into several lots and move the hogs from one to the other as occasion requires.

The length of the season during which this pasture is furnished also varies. Alfalfa is ready for pasture on the average from the middle of April in southern Oklahoma to the middle of May in northern Kansas. In many cases it will do to pasture earlier, but it is not best, as the young alfalfa has not the start it should have for heavy pasturing, nor has it the strength in the plant. When not pastured too early it will furnish feed at the rate mentioned during nearly the whole season until October in the North and November in the South. In some years the pasture season will continue a month later in the autumn, depending on the rainfall and the lateness of cool weather. In some seasons, if the summer is unusually dry and hot, the pasture will become short; but usually pasture for the number of hogs previously specified can be depended on for about seven months of the year in the southern limit of the territory named and for about five months in the northern limit. This rule will apply to other sections of the country in the same latitude as Oklahoma and Kansas.

While many farmers pasture alfalfa fields to their full capacity, in some sections, especially in northern Kansas, it is customary to run about half as many hogs as the alfalfa fields will support. This practice permits the cutting of the usual number of crops of hay, though the yield of hay is, of course, reduced.

Alfalfa not only furnishes a great amount of pasture, but it is of a character that goes to make bone and muscle. It belongs to the leguminous family of plants, as do the clovers, the cowpea, the field pea, the soy bean, and the vetches, and while it is furnishing this valuable food it is at the same time adding fertility to the land. Alfalfa pasture or alfalfa hay and corn are very nearly a balanced ration for animals, and while it is better to have a grain ration fed with it to hogs as well as other animals, yet a healthier, thriftier hog can be raised on alfalfa alone than on corn alone. Many instances are found where hogs have been raised on alfalfa alone. One Oklahoma farmer marketed in December, 1905, 61 head of spring pigs eight months old that averaged 171 pounds. These hogs had run from the time they were little pigs with their mothers on 15 acres of

alfalfa without any grain. They sold on the market for 5½ cents a pound. This made the cash value of the alfalfa pasture about $38.35 per acre. As will be seen, this is light pasturing, as there were only about 4 pigs per acre besides the brood sows.

As already stated, it is much better economy to furnish a grain ration with the pasture, as it results in better gains and a better product. One man estimates that it takes from one-half to one-third less corn on alfalfa pasture than on a straight grain ration to make a hog ready for market. Many let the hogs run on alfalfa until about five to six months old, by which time they reach a weight of 75 to 125 pounds, feeding just a little grain; then they feed heavily for about two months and sell the hogs at eight months old weighing 200 to 225 pounds. One farmer, who raises about a thousand hogs a year and who in one year sold $11,200 worth of hogs, makes a practice of growing his hogs on alfalfa pasture until about eight months old, feeding one ear of corn per head daily. He then feeds heavily on corn for a month or two and sells at an average weight of 200 to 225 pounds. Another man feeds all the corn and slop the pigs will clean up, all the while running them on alfalfa pasture, and sells at six to eight months old at weights of 250 to 300 pounds. Another, who raises about a thousand head a year, feeds all the corn the pigs will eat, beginning shortly after weaning and continuing until the hogs are sold at ten to eleven months old, averaging about 275 pounds.

Still another farmer, from weaning time (two months old) until eight months old, feeds the pigs nothing but dry corn on alfalfa pasture, averaging about one-half gallon of corn (3½ pounds) a day per head. At the end of eight months he sells at an average weight of 250 pounds. Feeding the above quantity of corn a day makes the amount fed about 11¼ bushels per head. Figuring this at the average price of corn in this locality, 35 cents, and the price received for pork, 5½ cents, the following results will show the cost of growing pork on this farm and the value of alfalfa pasture:

Value of 250-pound hog, at 5½ cents	$13.75
Value of pig at weaning, 50 pounds, at 5½ cents	2.75
Gain from pasture and grain	11.00
Cost of 11¼ bushels of corn, at 35 cents	3.93
Value of pasture per head pastured	7.07

Now, compare these results with those of a man who had to depend on other pasture crops than alfalfa. He estimates that it will take 15 bushels of corn on wheat, oats, and rye pasture to raise and fatten a hog so it will weigh 240 pounds at nine months old, besides the pasture and slop. At the price of corn mentioned, 35 cents a bushel,

and with hogs at 5½ cents a pound, note the cost of producing pork on this farm:

Value of 240-pound hog, at 5½ cents	$13.20
Value of pig at weaning, 50 pounds, at 5½ cents	2.75
Gain from pasture and grain	10.45
Cost of 15 bushels of corn, at 35 cents	5.25
Value of pasture per head pastured	5.20

The pasture specified here will not support more than half as many head per acre on this farm by feeding corn all the time. The value of this pasture is only $5.20 per head, against $7.07 per head for alfalfa pasture on the other farm.

The experiences of these men are sufficient to show the value of alfalfa pasture alone, and its greater value when grain is fed in connection, and that it is an important factor in economic pork production. A little later in this bulletin will be given the feeding systems of some farmers which will still further show the excellence of this forage crop and others and the cost of producing pork under such systems.

ALFALFA HAY.

While alfalfa pasture has been found to be very valuable for hogs, the hay as a part ration for winter is scarcely less important. Throughout the region referred to the farmers are feeding the hay to hogs in winter. Many feed the hay by throwing it on the ground in forkfuls; others have made low racks in which the hay is placed, where the hogs can feed like cattle or sheep. The hay has been found to be especially valuable for brood sows before farrowing. Where it is fed during the winter only a small grain ration is necessary to keep the sows in good flesh and in healthy condition. Sows thus fed also farrow good litters of strong, healthy pigs.

The hay is usually fed dry. The leaves are more readily eaten by the hogs than the stems, as they contain more of the nutritive value of the plant. For this reason some farmers save the last cutting of hay for the hogs because it is more relished. It is eaten up cleaner, as the stems are not so woody, and more food value is found in the leaves. Sometimes the hay is cut up fine, wet, and mixed with other feed, and sometimes it is fed ground, as there are now alfalfa mills scattered throughout the alfalfa regions. But it is very doubtful whether this extra expense will pay, unless it be for a ration for young pigs.

To avoid the expense of cutting or grinding, some farmers in order to get the hay all eaten have soaked it in water and fed it. This has proved very satisfactory where tried. One Oklahoma farmer carried his hogs through a winter by feeding them alfalfa leaves soaked in hot water for one day and the next day shorts mixed with the pulp and water. He feeds much alfalfa hay to his hogs and is very successful with them. He puts the last cutting in shock as soon as wilted, and thus cures it without bleaching and feeds it to his hogs. Another farmer carried his entire herd of hogs through the winter by feeding them the pulp of alfalfa hay after soaking it in water over night. He also gave them the water to drink. This was all the feed they had during the winter, and they were in good flesh in the spring, with smooth glossy coats of hair. A Kansas farmer was feeding a bunch of 50 fall pigs on corn; during the winter they got off feed and were not thrifty. He reduced the corn and gave a ration of two-thirds chopped alfalfa hay and one-third corn meal, the two soaked together. The hogs began to do better, and a little later he changed the ration to one-third alfalfa and two-thirds corn. The results were very satisfactory, and the cost of feed was reduced from $15 a month on corn to $9 a month on alfalfa and corn. So alfalfa hay, as well as pasture, has a very important use on a hog farm.

WHEAT.

In northern Oklahoma and southern Kansas fall wheat is a staple crop. It is generally seeded from the middle of September to the first of October. The seeding is usually 1¼ to 1½ bushels per acre. If the ground has been well prepared and the fall is not too dry, this will have made a good growth by the time alfalfa pasture is beginning to fail, along in November. The season here usually remains open until Christmas, so that six weeks of very good pasture are furnished. Some winters are so open that the wheat remains green most of the winter and stock find pasture all winter. The spring opens up by the last of February and the wheat gets green again in March. By judicious pasturing, not pasturing too heavily or when the ground is muddy, much green feed may be had without injury to the wheat. The farmers here have taken advantage of this, and where they have their wheat fields fenced hog tight they turn the hogs from the alfalfa field to the wheat field in November and leave them there during the winter unless the wheat gets too short or the ground becomes muddy. The hogs remain in the wheat until April and do well with very little grain. At this time they can go back to the alfalfa field again. Thus, green pasture is furnished the year round.

Where this is possible two litters a year of 200-pound hogs can be raised with profit and pork produced very cheaply.

Wheat will not carry as many hogs to the acre as alfalfa. The usual number is about six head per acre, though some farmers claim that the maximum is about ten. One man claims that hogs are one of the best animals for pasturing on wheat, not trampling it out as cattle or horses do. Another farmer of large experience thinks it is dangerous to pasture pigs at about weaning time on wheat. He has lost twice, he thinks, from that cause. The last time he saved only 15 out of 45 head. He claims that wheat is too fibrous and collects in balls in a pig's stomach and intestines, causing inflammation, from which the pig dies. It is claimed by some farmers that wheat is injurious to hogs just as it begins to shoot in spring. More information is needed on this point. The usual practice is to remove the hogs from wheat in early spring and put them on alfalfa or other summer pasture, so that experience with wheat pasture later in the season is limited.

The value of wheat as pasture lies chiefly in the fact that it furnishes green feed for the hogs at a season of the year when it is very much needed, especially by young and growing hogs. By having pasture at this season there is a great saving of grain, very little being needed. It also enables fall pigs farrowed in September to be carried through the winter in good condition, thrifty and well grown, so that by giving corn in the spring they can be sent to market by June nearly as cheaply as the March pig can be shipped by December. Quite frequently, where hogs have been grown on alfalfa or wheat pasture, they will, when put on a heavy feed of corn, make a gain of 12 to 15 pounds for every bushel fed.

OATS.

In the same region where wheat is used for pasture, oats are also used for spring pasture and are highly spoken of by all who have used them. Some claim that hogs will do better on oats than on wheat. The hogs like them better and will eat them as long as they grow, while they do not like wheat when it begins to head. In this locality many sow oats in March to furnish spring pasture for the hogs when they come off the wheat and before the alfalfa is ready to pasture. Sometimes oats are sown with rape at this time for the same purpose and to give variety to the pasture. Oats will furnish pasture at about the same rate as wheat.

The great value of oats is due to the fact that they furnish succulent feed at a season when it is much needed, giving variety to the pasture. They are also greatly relished by hogs. Oats are particu-

larly valuable as pasture for sows and young pigs, many farmers sowing them for this purpose. One farmer claims that he is less troubled with scours in pigs on oat pasture than on alfalfa.

RYE.

Rye is not so generally grown for a pasture crop in Oklahoma and Kansas as the crops just discussed. Many farmers, however, use rye to make a part of the pasture crop for their hogs, and its value can not be denied.

Rye is seeded from September 1 to the middle of October. The early seeding is best, as it comes on early and gets well established before cold weather and will thus make better fall and winter pasture. Rye is an excellent pasture for late fall, winter, and early spring. If not pastured too heavily in the spring it will head out and make a very good yield of grain. The grain is an excellent ration to feed with corn to pigs and growing hogs or to grind and mix in slop for sows with pigs.

The amount of pasture furnished by rye is about three-fourths that furnished by alfalfa, being estimated as supporting from 6 to 12 hogs per acre. One man reports having pastured 50 head of hogs on 5 acres during fall, winter, and spring, then harvesting 20 bushels of grain per acre. In the southern part of this region rye would be an excellent cover crop for the soil during the winter. Besides furnishing pasture it could be turned under as a green manure to add humus to the soil.

LESS IMPORTANT FORAGE CROPS.

While alfalfa, wheat, oats, and rye are the principal forage crops, there are others that are used to some extent. Among these are clover, rape, sorghum, cowpeas, soy beans, artichokes, and grasses.

CLOVERS.

The clovers are not generally used in the territory discussed. Among those most used for pasture crops are red clover and white clover. These are good, especially in the latitude of central Kansas and farther north, but south of this the clovers do not do so well. Red clover and white clover are the older pasture crops and are in more general use in the older sections of the country. They are both excellent forage crops for hogs. Red clover comes in well in the rotation of crops; it fertilizes the land and furnishes both pasture and hay. It is often sown with oats or barley in the spring, or later in corn after the last cultivation. It does very well with corn

where there is sufficient rainfall, but in the drier regions this method of seeding clover is not to be recommended. The first fall it is used for pasture; the second season it is used as a pasture and hay crop. It will furnish pasture for about ten head of hogs per acre during the first half of the season and half that many the last half, provided the soil is fairly good and the season not too dry. The hay is excellent for hogs, especially for brood sows in winter, but does not equal alfalfa hay.

White clover is better used in permanent pasture with some of the grasses, as Kentucky bluegrass. It will not furnish as much pasture as red clover, but is especially good while in bloom during May and June. It does better on moist ground than red clover and will do very well on some poor soils. It is not recommended to sow alone nor for hay, although the dry hay contains upward of 14 per cent of crude protein.

Alsike clover is better in some regions than red clover, especially on low, moist ground. In some localities farther north it does better and is a more certain crop. It will supply about as much pasture as red clover, is seeded at the same time, and furnishes pasture for the same period. As a hay crop it will not yield as much, but it is a little better than red clover, as it does not have as woody a stem.

Crimson clover has not succeeded well in the past in this region, but is to be recommended for further trial as a pasture crop. Along the Atlantic coast, the only region where it is largely and successfully grown, it has been found that the hairs of the blossoms are likely to gather in dense balls in the stomach and intestines of animals, especially the horse, and cause death. For this reason it should not be cut for a hay crop after the flowers mature. It is an excellent winter pasture crop for swine, however, and will furnish more pasture than red clover. It is a winter annual, and should be sown in August or September.

The chief value of crimson clover is that it acts as an excellent cover crop for soil during the winter months and prevents the soil from washing or leaching. It also furnishes in southern regions excellent winter and early spring pasture for hogs.

RAPE.

Rape is usually sown in early spring—in March or early in April—in Oklahoma and furnishes pasture by May. The Dwarf Essex variety is used. It is seeded either broadcast, at about 4 pounds of seed per acre, or else in drills 30 to 32 inches apart, using 3 pounds per acre. Drilling is the best method, as this permits of cultivation. The plants grow more rapidly and make pasture sooner. When sown in drills,

the hogs will not break down and destroy so much of the crop. Early-sown rape will furnish pasture from May until August. If rape is not grazed too closely in the spring and the stalk is not eaten off, it will grow up and make fall pasture.

A good growth of rape will supply pasture for about 15 or 20 hogs to the acre. One man claims that it will take 25 head to pasture it down.

It is often difficult to get hogs to eat rape at first if they have not been accustomed to it. For this reason it is not grown by some. Its value as a forage crop, however, is shown in the experiments of the Wisconsin Agricultural Experiment Station, where it was proved to have a feeding value per acre, when combined with a ration of corn and shorts, equivalent to 2,436 pounds of grain and a money value of $19.49 per acre. When the cost of seeding is counted, rape proves valuable for pasture, as the seed can be bought usually for 8 cents a pound and 3 to 5 pounds an acre is all that is needed. Rape should not be pastured until it is a foot high.

Considerable complaint is found with rape because it causes sores and scabs on the hogs. Sometimes the skin has the appearance of being blistered. This is especially true of white hogs. This difficulty can be remedied somewhat by removing the hogs to other pasture crops for part of the time and applying a mixture of sulphur and lard to the sores.

As one of the annual forage crops rape is valuable on account of the cheapness of the pasture, the quantity of feed furnished, the general thriftiness of the hogs on the pasture, and because it adds variety to the ration and is available at a time when other pastures may be short.

SORGHUM.

Sorghum is used quite extensively in the drier upland regions for summer pasture. It is valuable on account of the great amount of feed furnished, pasturing from 20 to 30 head of hogs per acre. It comes in as a summer pasture when other pastures are frequently short on account of hot, dry weather. It is sown in May and furnishes pasture during July, August, and September, or even later.

Sorghum is less palatable and nutritious than many other forage crops adapted to this region. For this reason many do not like it as a pasture crop. Hogs do not thrive as well on it as on alfalfa and require more grain to keep them growing nicely.

The special value of sorghum lies in the fact that it furnishes a great abundance of pasture in dry, hot weather when alfalfa makes little growth. After it is well started, say 2 feet high, it will furnish fairly good pasture for 30 hogs to the acre for a few weeks, and

a good crop will carry 25 head of 100-pound pigs nearly all summer. Generally speaking, it is used only to fill in during dry, hot weather when alfalfa is at a standstill.

COWPEAS.

Cowpeas are just beginning to be recognized in this section as having great feeding and fertilizing value. They do much toward restoring the fertility of the soil, and some farmers are making use of the vines as a forage crop for their hogs. Wherever they have been tried the farmers are enthusiastic in their praise of them. Not enough data have been obtained on pasturing to be able to say how many head of hogs cowpeas will support per acre; but in a comparison of their feeding value with corn for hogs the results obtained by the South Carolina Experiment Station show their importance. In this test 6.02 pounds of corn and 4.91 pounds of cowpeas were necessary to produce a pound of pork. One farmer in Oklahoma reported that his hogs preferred the cowpea hay to alfalfa hay. All kinds of stock are fond of the hay and do well on it.

The value of cowpeas as a forage crop lies in the fact that they furnish a food on which the hogs make good gains. The plants will make a good growth on rather poor soil and furnish feed during late summer and fall when other green crops may be short. They also bring the soil into a more productive state, the same as clover or alfalfa.

If cowpeas are planted in May they will make late summer pasture. The best pasture is obtained after the peas are formed and well grown, as the peas are very nutritious and cause the hogs to gain in flesh rapidly.

In this same latitude in the higher altitudes, as in the San Luis Valley in southern Colorado, where it is too cold for corn, the farmers have found the Canadian field pea a very profitable crop for forage both for sheep and hogs. A large acreage of these peas is put in each year, the peas being sometimes sown alone, but more frequently with oats or barley. The seeding is done in April or early in May, and the crop can be pastured by midsummer. The best season for pasturing however, is later, when the peas have formed, the stock being allowed to harvest the crop. Hogs make a very thorough harvesting, cleaning up the peas and the vines quite thoroughly. What vines are left on the ground, together with the manure, enrich the soil and add more humus to it. In addition to this the labor of harvesting is saved. Some fields, of course, are harvested for hay and make excellent winter forage for cattle, horses, and sheep. The hogs raised in this valley receive no corn. They go on the market as bacon hogs and top the market in competition with corn-fed hogs. These hogs usually get no

farther than Pueblo, Leadville, Silverton, and adjoining towns. The Pueblo packers have been using them for a number of years and speak very highly of them. Thus, the field pea has made the hog industry profitable outside of the corn belt.

SOY BEANS.

The soy bean is used but little as a forage crop by farmers in this section, and the value of this crop is but little appreciated. Soy beans can be planted on a field from which a small grain crop has been removed, and some varieties will make an excellent growth of forage and even mature seed. They will thus furnish pasture for hogs during the latter part of August and September, and the green and ripening beans when harvested by the hogs in this way make an excellent feed. The beans when fed in a ration consisting of one part beans and three to five parts of corn or Kafir corn, as shown by the Kansas Agricultural Experiment Station, make a very profitable ration for fattening hogs. The saving in the amount of feed necessary to make a gain of 100 pounds is from 13.2 to 37.5 per cent and the increase in gain is from 14.6 to 96.4 per cent. Also, in a feeding test at the Indiana Agricultural Experiment Station, where soy beans, middlings, and tankage were used as rations with corn, the soy beans proved to be the most valuable adjunct used. As compared to corn fed alone, hogs that received one-third soy beans to two-thirds corn made two and one-fifth times as much gain in the same length of time. The cost per 100 pounds of gain where corn was fed alone was $5.01 against $3.59 where one-third soy beans and two-thirds corn was fed. Hogs so fed look thrifty, have a good appetite, fatten rapidly, and have glossy hair like animals fed oil meal.

The great value of the soy bean is its power to withstand excessive drought, like Kafir corn, and it will also withstand much wet weather. It is not attacked by chinch bugs and in addition to its great feeding value makes an excellent second crop following wheat or oats to build up run-down or thin soil. Protein is very necessary in a ration for building bone and muscle, as all feeders are coming to know, and the soy bean is exceptionally rich in this. It even stands ahead of alfalfa in this respect.

GRASSES.

The grasses are not so good for hog pasture as the crops previously mentioned, but they are used to some extent. Those most commonly grown are Kentucky bluegrass, English bluegrass or meadow fescue, Bermuda grass, and the native wild grasses.

Kentucky bluegrass is used through Kansas and southern Nebraska. South of Kansas in Oklahoma Bermuda grass is used.

As an example of the value of English bluegrass, the experience of one farmer in northern Oklahoma may be cited. He uses only English bluegrass and wild grass as pasture. On 12 acres of the bluegrass sown the fall before, he pastured 150 head of stock hogs all the spring until about the middle of May. The hogs were then taken off and the grass allowed to go to seed. This farmer states that he harvested a crop of seed larger than the ordinary crop.

Bermuda grass is not much used as a pasture for hogs, but should be grown more in regions to which it is adapted. It is relatively rich in protein, is not easily killed out by pasturing, and withstands drought well. It is often used as a soil binder and might well be used for hog pasture. Many hilly farms that are now washing badly could be put in Bermuda grass and pastured to stock, thus saving the land and building up the soil. Some farmers are beginning to make use of this grass and are fencing it for hog pasture. It withstands heavy grazing, rooting, and trampling.

Some farmers have fenced in the prairie grass and are now grazing their hogs on it. While it does not have a very high feeding value, hogs will do very well on it with grain. One man claims that prairie grass will make hogs hold their own at the rate of 6 head per acre.

ROOT CROPS.

The root crops most used in this territory are potatoes, artichokes, peanuts, and sugar beets.

Artichokes are a very good root crop to use for hogs. They can be planted in the spring the same way as potatoes and cultivated the same. In the fall the hogs can be turned in to harvest them. They thus furnish a good late fall and winter food, especially for brood sows and shoats. One farmer claims that 1 acre will keep from 20 to 30 head in fine condition from October till spring. Their use reduces considerably the amount of corn that must be fed. None of the tubers need be dug except for seed; the hogs will dig the rest. Early in the fall hogs do not eat artichokes readily. In winter and spring they eat them greedily.

Artichokes have a tendency to become a pest on cultivated land, or if planted continuously on the same land they become diseased. They may be grown very successfully, however, in a pasture crop rotation for hogs. As the acreage needed is not large, they can be planted on a part of a field in March or April and the rest of the field sown to rape. In August the part sown to rape can be reseeded to rape for fall pasture. This field can be sown to oats the next spring after rape, and barley sown after the artichokes. The crop may be pastured continuously if needed, or later mowed for hay. In August, after this crop is

removed, rye and clover may be sown. This will furnish pasture for the ensuing fall and for the following year. This makes a three-year rotation of pasture crops that fit in very well with each other. Preparing the land in July and August for the following crop of rye and clover effectually eradicates the artichokes.

The Oregon Agricultural Experiment Station made a test to determine the feeding value of artichokes with grain for hogs. The result of the test showed that where artichokes were fed there was a saving of nearly 2 pounds of grain for every pound of gain in live weight. Besides, the hogs were healthy and vigorous all the time.

The artichoke is superior to the common beets and turnips for hogs—about the same as potatoes—and they are richer in protein than sweet potatoes.

Peanuts are but little used in this region, but farther south and east they are used extensively. One man estimates that when pork is 4 cents a pound, peanuts return $10 per acre when harvested by hogs.

The Alabama Agricultural Experiment Station made investigations as to the relative value of peanuts, chufas, cowpeas, rape, sorghum, and sweet potatoes as pasture crops for hogs. The amount of grain required with peanuts to make 1 pound of gain was 1.77 pounds; with chufas, 2.3 pounds; with rape, 2.68 pounds; with cowpeas, 3.07 pounds; with sweet potatoes, 3.13 pounds, and with sorghum, 3.7 pounds. Five Tamworth hogs in twenty days on Spanish peanuts gained 2.29 pounds a day each.

Peanuts can be very profitably grown in many sections of the latitude of Oklahoma and Kansas. This crop will do better on a sandy loam than on a heavy clay soil, and will make a fair crop on thin soil where corn will not yield well. They are a very good crop to raise, both for pasture and for hay; stock of all kinds are very fond of the hay. When the nuts are left on, it is richer in protein than alfalfa hay. The variety best to grow, both for hay and pasture for hogs, is the Spanish peanut. It is a small-sized nut and grows in great clusters close around the taproot of the plant. The Spanish nut is not so particular in soil requirements as the larger varieties and is easier harvested on account of growing in clusters.

It is claimed that peanuts can be grown in dry regions where corn will not succeed. This, if true, is important in the southern-plains region. Peanuts can be made to take the place of corn in fattening hogs, although the peanut-fed hog makes softer lard and the quality of the meat is not so good, especially in the bacon hog. But as an adjunct to corn the peanut is an excellent forage crop. It is claimed that the northern-grown nut is better flavored and less oily than that grown in the South.

The peanut can be planted the last of April or first of May in the latitude of the regions discussed in these pages and is ready to turn the hogs on by the last of August.

In Colorado, in the sugar-beet district, hogs have been fed quite extensively on beets in the winter. Beets do not prove satisfactory when fed alone, but are used to some extent as part ration with grain. One farmer states that he saves a good supply each year to feed in the winter to his hogs to keep them in a healthy condition.

In a feeding test at the Colorado Agricultural Experiment Station sugar beets proved to be wholly unsatisfactory when fed with grain. The cost per hundred pounds of gain of beets and barley fed hogs was $6.01; of beets and corn fed hogs, $7.22, the latter being higher than any other ration fed.

PUMPKINS.

Pumpkins are an excellent feed for keeping hogs in a healthy condition. Many farmers claim that the seeds of pumpkins will prevent worms in pigs and shoats and that a ration of pumpkins fed with grain will keep hogs thrifty and give them a good appetite. A good many wagonloads can be grown on an acre of rich land. Stumpy land or low moist land will grow good pumpkins.

PASTURE CROPS FOR DIFFERENT SEASONS.

It is not the purpose of this bulletin to discuss the rotation of crops and its importance on the farm, but the aim is to briefly mention the forage crops that are adapted for hogs each month of the year in this region and to explain how they can be made to overlap each other, so that green pasture can be provided for each month in the southern part of the territory discussed and for the greater part of the year in the northern part. Hog raisers know that some months of the year there is an abundance of pasture, while at other seasons there is very little, if any. At such times other feeds must be resorted to that will supply the deficiency. The extra feed required is expensive and cuts down the margin of profit in pork production.

It will not be practicable to name the crop that is best adapted to every locality for the different seasons, as each farmer must know his soil and conditions and adapt his crops to those conditions. The following table will show the crops that may be ready for pasture in the months specified and the possible area of pasture provided, but the choice of one or more of these must be left to the farmer himself.

TABLE I.—*Crops that may be available for pasturing hogs every month in the year, with the number of head an acre will support.*[a]

For pasture during—	In the latitude of—	Crops that may be used.	Time of sowing.	Number of hogs that can be pastured per acre.
April and May	Oklahoma	Alfalfa	Previous year	8–16
		Rye	Previous fall	6–10
		Oats	March 1	6–10
		Rape	do	15–20
	Kansas	Alfalfa	Previous year	8–16
		Rye	Previous fall	6–10
		Clover	do	6–10
		Oats	Last of March	6–10
		Kentucky bluegrass.		8–10
		English bluegrass	Previous fall	8–12
		Spring rye	March 1	6–10
		Late oats	April 15	6–10
June and July	Oklahoma	Sorghum	March 1 to April 1	20–30
		Alfalfa	Previous year	8–16
		Potatoes	March	(Unknown.)
		Rape	March 1 to April 15	15–20
	Kansas	Spring rye	April 1 to 15	6–10
		Late oats	April 15 to May 1	6–10
		Sorghum	April 1	20–30
		Alfalfa	Previous year	8–16
		Prairie grass		5
August and September	Oklahoma	Sorghum	April	20–30
		Cowpeas	May	10
		Soy beans	do	13
		Peanuts	April	8–10
		Alfalfa	Previous year	5–10
	Kansas	Sorghum	May 1	20–30
		Cowpeas	do	10
		Soy beans	do	10
		Peanuts	do	8–10
		Potatoes	April 1	(Unknown.)
		Alfalfa	Previous year	5–10
October and November	Oklahoma	Alfalfa	do	7–14
		Wheat	September 15	6–8
		Rye	September 1	7–10
		Sweet potatoes	May 1	8–12
		Artichokes	March or April	15–25
		Rape[b]	do	15–20
	Kansas	Alfalfa	Previous year	7–14
		Wheat	September 1	5–6
		Clover	March or April	6–10
		Peanuts	May 1	8–10
		Rye	September 1	5–6
		Sweet potatoes	May 1	8–10
		Artichokes	April	15–25
December and January	Oklahoma	Wheat	September 15 to October 1	5–8
		Rye	September	5–8
		Artichokes	April	15–25
	Kansas	Wheat	September 1	5–8
		Rye	do	5–8
		Artichokes[c]	April	15–25
February and March	Oklahoma	Wheat[d]	September 15 to October 1	5
		Rye	September	6–10
		Artichokes	April	15–25
	Kansas	Rye	September 1	5–10
		Artichokes[c]	April	15–25

[a] The number of hogs that can be pastured per acre, it must be remembered, depends on the fertility of the soil, on the season, and on the size of the hogs. This estimate is based on the same figures as were secured on alfalfa pasture; i. e., hogs that weigh from 50 to 125 pounds per head.

[b] Rape will furnish fall pasture as indicated if it is not pastured too close in the spring. It will branch out from the roots and stem in the fall. It may also be planted in August for fall pasture.

[c] Artichokes are available when not frozen. They may be left in the ground until it thaws in the spring, when the hogs will finish harvesting them.

[d] Wheat should not be pastured after the 1st of April if a crop of grain is desired.

SYSTEMS OF HOG FEEDING.

Nearly every farmer who has succeeded with hogs has a feeding system of his own, yet there are some features common to all. A good illustration of the successful handling of hogs on a small farm is that employed by a man in northern Oklahoma on an 80-acre farm. He has his whole farm fenced hog-tight and turns off annually from it an average of 100 head of hogs. All these are of his own raising and are grown and fitted for market with the crops raised on his farm, with the exception that a little corn is occasionally bought. He has 5 acres of alfalfa and each autumn sows 5 acres of wheat for late fall and winter pasture. In the spring he sows oats to supplement the wheat and alfalfa. The wheat is sown at the rate of 1½ bushels to the acre, about September 1, and furnishes pasture in the fall, when alfalfa pasture is getting short, and for a part of the winter. The wheat will also furnish some pasture for the hogs in the spring. The oats tide over until the alfalfa is ready for pasture. Thus, green feed is furnished for the greater part of the year. The rest of his 80 acres this farmer plants to corn. A part of this corn is fenced off and "hogged down" in the fall. As fast as the hogs need it the fence is moved over, and fresh corn is taken in. This pasturing is begun at the same time that corn is usually cut up green and fed to hogs, i. e., when it is in the roasting-ear stage. Spring pigs are turned on this. This plan of feeding is kept up until the remainder of the corn is all husked from the field. Then the hogs are turned in to clean up the waste corn in the field. Last summer cowpeas were drilled in the corn when plowing the last time. These furnished much valuable feed in addition to the corn.

In April this man had 20 head of fall pigs averaging about 125 pounds. These shoats had had no feed except wheat and alfalfa pasture and the waste grain they gathered from the field except a little corn that was thrown to them each day in the late winter and early spring. In April they were put on ground corn for thirty days. During this time each ate an average of one-fourth bushel daily. At the end of thirty days they averaged 225 pounds. This makes an average gain of 3⅓ pounds per day, or a little more than 13 pounds of gain for each bushel of corn fed. The market price of corn was 50 cents a bushel. The hogs sold at $5.50 per hundred, thus bringing 73⅓ cents a bushel for the corn fed.

This farmer raises two litters of pigs a year, farrowed in March and September, turning off fall pigs in the spring and spring pigs in the fall, selling at 6 to 8 months old. From March 15 to November 1, 1906, he turned off $720.50 worth of hogs and had 22 head in the fattening pens, all of his own raising and all grown and fattened on the products of his own farm.

Another farm in the same locality will serve as an illustration of what may be done with fall pigs in this section. Eighty head ran on the alfalfa and wheat fields of the farm during fall and winter. They gathered roughage and waste grain in the fields and were fed no grain until 6 months old. At this age they averaged 135 pounds. They were then fed some corn on alfalfa pasture, the amount gradually increasing till the pigs were on full feed. Corn was fed for two months, during which time the pigs made an average gain of 14 pounds for every bushel of corn fed. They were sold at 8 months old, weighing 235 pounds each. The price of the corn was 45 cents a bushel. This makes the cost of the corn fed $257.14, or $3.21 for each hog. At the average price of hogs in this locality, 5½ cents, the herd averaged $12.92½ per head. Deducting the price of corn fed leaves, as the value of the fall and winter pasture for each hog, $9.71.

Another farmer ran a bunch of September pigs on alfalfa and wheat pastures until the following May, when they weighed 125 pounds. They received in addition one ear of corn each twice a day. At this time the corn was increased gradually until each hog was getting 10 ears twice a day, which this farmer claims is the maximum feed for young hogs. They were fed thus for six weeks, making in this time a gain of about 100 pounds a head and consuming 10 bushels of corn each at a cost of $3.50 a head, or 3½ cents a pound for each pound of gain on corn. Allowing 4 bushels more as the quantity probably fed up to the fattening period at two ears a day, makes the cost for corn for each hog $4.90. To this adding $1.10 a head for pasture and slop (the cost of the slop fed is not known) brings the cost of each hog to $6.50 a head, or 2⅔ cents a pound. This allowed a good margin of profit at the ruling price of pork.

To show the importance of alfalfa hay in a system of feeding, the practice of the farmers around North Platte, Nebr., and elsewhere may be mentioned. The alfalfa hay is ground up fine or else fed whole with corn in the proportion of about 5 pounds of alfalfa to 1 pound of corn. This is fed to the brood sows during the winter, and they come through in excellent condition on very cheap feed. In many sections alfalfa hay is worth about $5 a ton on the farm. One ton of alfalfa and about 8 bushels of corn will keep three brood sows one hundred and thirty days, or nearly the whole winter. The hogs so kept farrow pigs that are remarkable for their vigor and size.

In these times of scarcity of labor and its high price many farmers are trying to reduce the labor on the farm. Some of the hog raisers have adopted the plan of harvesting the corn crop by turning the hogs into the cornfield and letting them gather it, or "hogging it down," as it is called.

One man in Ohio turned 122 spring pigs and older hogs into a 10-acre cornfield in September. The total weight of the hogs was 15,693 pounds. The spring pigs averaged 82 pounds and the older hogs 156 pounds. There was about the same number of each kind. The corn would yield about 60 bushels an acre, and in it there were a good many pumpkins. The hogs had access also to a 5-acre clover field from which the seed had been removed. Water was hauled to them and they had the shade of the woods near by. In twenty-eight days the hogs had gained 6,522 pounds. At this time 57 head were sold, averaging 245 pounds, bringing $5.15 per hundred. The remainder were not sold, but the farmer was offered $5 per hundred for them. Counting the entire gain of 6,522 pounds at $5 would make $327.60, or $31.20 per acre for the field. This paid 52 cents a bushel for the corn which on the market was worth 40 cents. The whole herd of hogs made an average daily gain of 1.92 pounds.

Another man in southern Kansas makes a practice of "hogging down" corn. He uses a portable fence and fences off 5 to 10 acres at a time, taking in more as needed. He turns the hogs in the corn in August. On 12 acres of corn one year he fattened 50 head of hogs, using about 600 bushels of corn. Of the bunch 42 head were sold, averaging 240 pounds, netting $600. Allowing 100 pounds gain for each hog on the corn thus fed, the corn brought 41¼ cents a bushel, without the expense of gathering.

Another man in Oklahoma has been "hogging down" corn for a number of years. About 500 head of hogs are turned off this farm every year. By gathering and weighing corn beside that which was gathered by hogs, it was found that a bushel of corn "hogged down" will make as much pork as the same quantity husked and fed, while the expense of harvesting is saved; besides saving the labor of feeding the corn to the hogs the field is also cleaned up better than a husked field.

An Iowa farmer began hogging down corn several years ago, using 20 acres the first year. He watched carefully the feeding of the hogs on this field and concluded that no more corn was wasted than would have been left in the field by the average husker. Since that time he has hogged down all his corn, thus saving the expense of husking. This man says the cost of husking for one year will fence the field hog-tight if there is already a wire fence for cattle. Husking 40 acres of corn yielding 40 bushels per acre, at 4 cents per bushel—it has cost nearer 5 cents the last season (1907), figuring board, etc.—amounts to $64. If the 40 acres are a square field this allows 20 cents a rod for the fence the first year. With a cattle fence already provided this will buy the wire to make it a good hog-tight fence. Besides this there are two other great objects to

be attained by this method of harvesting corn: (1) The improvement of the land and (2) the health of the hogs. The farmer referred to says that in his first year's experience he snapped 20 acres of corn beside the field hogged down. The next spring both were sown to small grain under the same conditions and with the same preparation. The wheat on the land where corn was hogged down made 5 and the oats 7 bushels more to the acre than did the other. The difference is just as noticeable in a succeeding corn crop. The husks, cobs, stalks, and leaves all remain on the land, and these, with the manure from the hogs, enrich the soil and add organic matter to it.

The health of the hog is another important item. Hogs that have plenty of range and exercise are not nearly as susceptible to disease as those confined in a small pen. A hog that goes out after his feed will be well grown and thrifty, accustomed to the elements and not liable to be injured by a sudden change of weather. It is difficult to put a good finish on hogs while running in a large pasture. If they are allowed to run on good pasture until three weeks or a month before sending to market, and are then shut up and given all the corn they want, with plenty of pure water, they will make very rapid gains.

This man allows his pigs to run in the corn as soon as the land is plowed the last time, but does not let the older hogs into the field until the corn is in good condition to feed in the fall. He says he has also had good results from letting cattle into the corn first and following these with hogs. He thinks this is the most practical solution of the labor problem when help is so high-priced and scarce.

As stated in the beginning, it is the aim in this bulletin to deal with some of the practical problems that are confronting the farmers of this country. Facts that have come under the writer's observation in the past year (1907) have been stated as concisely as possible and applied to the territory visited and to similar latitudes. It is impossible, as already stated, to prescribe for the wants of each individual farmer in the limits of a bulletin such as this. The facts are given in a general way, and it remains for each hog raiser to pick and choose for himself as his judgment dictates.

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B. T. GALLOWAY, *Chief of Bureau.*

THE CULTURE AND USES OF BROME-GRASS.

BY

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THE CULTURE AND USES OF BROME-GRASS.

INTRODUCTION.

It is the purpose of this bulletin to describe some of the more general methods used in the growing and utilization of brome-grass in the sections where it is now of most importance, and not to discuss in complete detail its culture throughout the entire United States. While the methods described are those employed in North Dakota, South Dakota, and the Canadian Northwest, they are also applicable in general to all other sections where this grass can be grown. The treatment given the subject is slightly inconsistent, since the methods actually practiced by the farmers and the suggestions and conclusions drawn by the writer from his investigations are combined in such a way as not to make them entirely distinct. It is hoped, however, that the matter will in this form be of more assistance to those contemplating the growing of the grass than were another plan of arrangement followed.

Brome-grass (*Bromus inermis* Leyss.), sometimes called smooth brome or Hungarian brome, is a vigorous perennial grass, possessing aggressive underground rootstocks by which it propagates readily. In general, it grows from 15 to 30 inches high, but under exceptionally favorably conditions it attains a height of 4 feet or more. The seed is borne in an open panicle closely resembling that of the well-known chess, or cheat, and is produced abundantly. (See Pl. I, fig. 1.) Although the grass is inclined to mat at the base, the entire stem is also quite leafy. (See Pl. I, fig. 2.)

Brome-grass was introduced from Europe about 1880 and has attained considerable importance in North Dakota, South Dakota, and the Pacific Northwest. It is grown in this country to some extent throughout the general region from Kansas north to the Canadian boundary and west to the Pacific coast, but its importance in the timothy and clover region is at present very limited. The grass is capable of withstanding severe cold and extended periods of drought, but it is seriously affected by heat, and consequently can not be grown successfully south of the southern boundary of Kansas except at high altitudes or under otherwise favorable conditions. It does well on

a variety of soils, but gives best results on soil that is well supplied with humus. It can, however, be grown very successfully on sandy or gravelly land.

In the Dakotas and the closely adjacent sections brome-grass is of more importance than in any other portion of this country. It has been grown in this region for twelve or fifteen years, but is as yet not so widely distributed as would be expected. Improved methods of growing alfalfa, making that crop more certain, are in a measure responsible for the comparatively limited use of brome-grass. This is true more especially in South Dakota than in North Dakota. In sections where alfalfa can be grown brome-grass can not compete with it as a hay crop. In the more humid portion of the above-named States and on the better classes of soil it has the reputation of being difficult to eradicate, and, whether this is warranted or not, this belief has a decided tendency to make the grass unpopular in such sections. For the above reasons and because there is still a considerable quantity of native hay produced, and consequently not such a pressing demand for cultivated grasses, brome-grass has not attained more importance than is the case at present.

METHODS OF CULTURE.

PREPARATION OF THE SEED BED.

For the preparation of the seed bed it is the common practice to plow the ground as early as possible in the spring, which in most sections is in March or very early in April. It is then put into condition for seeding by a thorough harrowing, or by disking, harrowing, and rolling. A careful preparatory treatment is considered essential in the securing of a good stand of grass. Some successful growers favor fall plowing, since this puts the land in better condition for seeding in the spring. Brome-grass follows all crops with practically the same results. It does well after corn, as well-cultivated corn ground is usually quite free from weeds. Wheat and oats, however, are most commonly the preceding crops.

SEEDING.

The seed is usually sown during the first part of April or as soon as the weather is favorable, which may be even as early as the latter part of March. One bushel (14 pounds) to the acre is considered by most growers to be a sufficient quantity of seed to produce a satisfactory stand, and good results are often obtained with 10 to 12 pounds. At the Manitoba experimental farm 10 pounds of good seed is recommended, and 10 to 12 pounds at the Saskatchewan experimental farm.

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FIG. 1.—A PANICLE OF BROME-GRASS (BROMUS INERMIS) IN FULL BLOOM.

FIG. 2.—A SINGLE PLANT OF BROME-GRASS (BROMUS INERMIS).

If desired for pasture alone, it is considered well to sow as much as 20 to 25 pounds to the acre, since this quantity gives a stand that will make good grazing sooner after sowing than a light seeding. Heavy seeding is advised for sections where the grass is being introduced or is not commonly grown. The decrease in recent years in the quantity of seed sown to the acre is due to the fact that home-grown seed is used and better methods are employed in cleaning and sowing it.

The amount of rainfall in any section usually determines whether the seed is sown with or without a nurse crop. In general, in the eastern half of the Dakotas a nurse crop is used, while in the western part, where the rainfall is less, the grass is sown alone. Wheat, oats, barley, and spelt are used as nurse crops and are usually sown at the same rate as when sown alone. The grass seed is sometimes mixed with the grain, but it is a more common practice to drill in the grain, sow the grass broadcast afterwards, and cover by harrowing across the drills. In sowing brome-grass seed with grain it is often difficult to prevent it from being covered too deeply, which usually results in an uneven stand. Difficulty is also often experienced in getting a mixture of grain and grass seed to feed evenly through the drill.

Even in the more humid sections of the Dakotas there is some difference of opinion as to the advisability of using a nurse crop. The best argument in favor of this practice is that returns are obtained from land which otherwise would be practically idle for one year, as the grass yields nothing the first season, even though sown alone. Seeding alone, however, usually gives a better stand, except, perhaps, on weedy land, in which case a nurse crop is quite effective in keeping down the weeds.

In the less humid sections, where brome-grass is most commonly sown alone, the preparation of the seed bed is essentially the same as in cases where a nurse crop is used. When the seed is sown with a drill, it is a good practice to harrow afterwards, as this treatment leaves the ground in a better condition to conserve moisture. The only objection to this method is that it is likely to cover the seed too deeply.

Where fall wheat is grown, brome-grass is sometimes sown with it. By the time the wheat is cut the next summer the grass has made a good growth, and a heavy crop of hay is secured the year following this. Throughout the entire brome-grass region there is some fall seeding done, the time of seeding varying from July to October.

Whether sown in the spring or fall, with or without a nurse crop, brome-grass generally does not make a very vigorous growth and yields practically no forage or seed the first season. When sown alone it is found necessary to mow the grass once during the summer to keep down the weeds. In this case the cutting should be allowed

to remain on the ground. Aside from this, the field receives no attention and in most cases it is not pastured in the fall. When grazed during the autumn of the first year care should be taken to avoid overpasturing.

RENEWAL OF MEADOWS.

Under ordinary conditions a meadow of brome-grass will remain productive for three or four years, depending largely on the kind of soil and the nature of the treatment which it receives. Although it has been grown for a number of years in this country, there has been very little done in an experimental way by farmers to determine the best methods of renewing old meadows. In the Canadian Northwest more attention has been given to this subject, and farmers there have obtained very good results by their methods.

The history of a field of brome-grass is in general as follows: During the season in which it is seeded very little is obtained from it, except, perhaps, a small amount of pasturage; the next year a very fair crop of hay is secured; the third year, a maximum crop; the fourth year the yield is considerably reduced; and following this it decreases rapidly, owing to the meadow becoming what is commonly called "sod-bound." As before stated, the decrease in yield after the third year depends to a large extent on the kind of soil, since on heavy, rich soils the grass usually remains productive for a longer period. The character of the season also is thought to have an effect on the life of the meadow, and some farmers are of the opinion that if conditions are exceptionally favorable for a large crop the second year the grass has a tendency to diminish in yield earlier than if an ordinary crop was produced at that time.

The method of renewal giving best results in the Canadian Northwest and also practiced to some extent in the Dakotas is that of shallow breaking, the time of year depending largely on the amount of rainfall. The experimental farm at Brandon, Manitoba, recommends that the meadow be plowed about 2 inches deep in June or early July, after a crop of hay has been removed, the sod being then rolled and worked down thoroughly. As a result of this treatment a good crop of hay is secured the following season. Farther west, in Saskatchewan and in the drier portions of the Dakotas, breaking the meadow in the spring, about May, gives best results. This method is recommended by the experimental farm at Indian Head, Saskatchewan. Satisfactory results have been obtained in the more humid sections from shallow-breaking the sod in the spring and putting it in condition for a light seeding of grain, oats being frequently used. If thought necessary, 6 to 8 pounds of brome-grass seed is added. In this way a crop of grain is secured the same year, and a good crop of grass the next, so that the ground is not

allowed to lie idle. Returns are of course obtained from the land if the breaking is done in June or July after cutting a crop of hay. In the drier portions spring plowing is necessary, but since grain can not be sown on the sod no returns are obtained until the following year. Good results are sometimes secured from breaking the sod in the fall and sowing oats or some other small grain in the spring. When this is done the grass comes on for a full crop the next year. This method, however, is not commonly practiced.

Disking appears to give better results in the humid than in the drier sections, but in general it can hardly be said to give entire satisfaction. Better results are obtained on sandy or loose soil than on a heavy soil where a tough sod is formed. Farmers who have done very little toward improving their meadows are commonly of the opinion that disking is an effective means of renewing them, but actual experiments indicate that the value of this treatment is considerably overrated. Harrowing with a drag harrow in July after the hay is cut has proved beneficial in some instances.

The practice of applying barnyard manure to unproductive meadows has not been followed to any great extent, and under present conditions it is hardly practicable. The results obtained from such treatment have not been very definite, and in some cases they have been quite contradictory. That a liberal application of barnyard manure, even when no other treatment is given, will materially increase the yield of hay from a so-called "sod-bound" meadow has been proved by reliable and successful farmers. Best results have been obtained by applying an even top-dressing early in the spring before the grass begins to grow. Sheep manure has been found to be very beneficial.

Hardly sufficient evidence has been obtained to warrant definite statements regarding the value of various fertilizers. Prof. J. H. Shepperd, of the South Dakota Agricultural Experiment Station, in the season of 1905 obtained some results that were very favorable to the use of nitrate of soda. At the Highmore station, South Dakota, experiments conducted with the same fertilizers in 1906 gave rather indifferent results. The data available on the subject of renewing meadows by either barnyard manure or commercial fertilizers are so incomplete and the practice of renewal in this way is so unusual that it is not considered advisable to discuss the subject further at this time.

MIXTURES OF BROME-GRASS WITH OTHER GRASSES.

Some attention is being given to mixtures of brome-grass with other grasses, and very good results are being obtained. The practice

so far is very limited, and the proportions of the different grasses to use and the methods of handling have not been well worked out.

At present timothy seems to be the most common grass used in mixtures: alfalfa, red clover, slender wheat-grass, meadow fescue, and orchard grass are also used. Grasses and clovers are mixed with *Bromus inermis* to improve the quality and yield of forage and, for what is probably of more importance, to prolong the period of productiveness by keeping the brome-grass from becoming sod-bound. Results of experiments to determine this period have so far been rather indefinite. It is probable that the sod-bound condition can be delayed for a short while, but not for any great length of time. Alfalfa and clover are of value also, since they tend to maintain the productivity of the soil, and where these plants are mixed with brome-grass they can be pastured with little danger to stock from bloating.

Timothy has been grown with brome-grass at the Manitoba experiment farm with very good results, but it is the opinion there that it does not materially increase the life of a meadow and that the brome-grass eventually crowds it out. This mixture is quite commonly grown throughout Manitoba. Mixtures have been tried on the experiment farm at Indian Head, Saskatchewan, and one composed of 7 pounds of *Bromus inermis* and 7 pounds of slender wheat-grass (*Agropyron tenerum*) has given good results. A meadow of this mixture after having been down for six years without renewing still remained productive, yielding two tons of hay to the acre. In the Dakotas experiments are being conducted with alfalfa and brome-grass, and there is a probability of the combination coming into general use where alfalfa can be successfully grown. Mixtures with orchard grass and meadow fescue have given indications of being worthy of attention. In all permanent mixtures the quantity of brome-grass seed used should be smaller than the sum of the other constituents, as brome-grass has a tendency to crowd out the other grasses.

USES AND VALUE.

PASTURE.

Although grown as a general-purpose grass, *Bromus inermis* is much better adapted for use as pasture than for hay, on account of its tendency to form a turf. It furnishes a large quantity of palatable pasturage, and is especially valuable because it can be grazed early in the spring and late in the fall, and unless the season is unfavorable it furnishes a considerable amount of feed during the summer. Where it is now being grown there are no grasses that can equal it for pasture on sandy land, as it not only produces well on such soil, but forms a sod that withstands trampling and is not easily pulled up

by stock. This is an important feature, especially where sheep are grazed. Even after the grass has become sod-bound and produces only light yields of hay it can still be pastured profitably for two or three years. While it is impossible at the present time to secure definite data in regard to the carrying capacity of *Bromus inermis* pastures, it can be conservatively stated that both in favorable and unfavorable seasons they furnish more grazing in the western part of the Dakotas than the native grasses and more in the eastern part than Kentucky bluegrass.

HAY.

Brome-grass is not an ideal hay grass, although for two or three years after sowing it gives a satisfactory yield of a very good quality of hay. On rich land the yield is better than the average for standard grasses, and the quality is good. (See Pl. II, fig. 1.) It is generally agreed that the best stage at which to cut brome-grass for hay is just after it has passed full bloom and is in the condition known as the "purple." The practice is, however, quite elastic in this respect, as the grass makes hay of good quality when cut either before or after this stage. No definite feeding experiments have as yet been conducted to determine the value of brome-grass hay in comparison with other standard hays or fodder, but general experience indicates that it is almost, if not quite, equal to timothy for cattle (especially dairy cows), for horses not at work, and for sheep. When properly cured it is very palatable and is relished by all classes of stock, but on account of its laxative properties it can not be recommended as a feed for livery horses or horses at hard work.

Different writers in discussing brome-grass disagree in regard to its nutritive value as compared with a standard grass such as timothy. Chemical analyses disagree also, and it is difficult to compare these grasses, since the samples have been taken at different stages of maturity and also under otherwise different conditions. The average of analyses given in Bulletin 56 of the Iowa Agricultural Experiment Station shows water-free samples of *Bromus inermis* to contain 3.48 per cent of fat and 14.14 per cent of protein, and samples of timothy under the same conditions to contain 4.83 per cent of fat and 12.27 per cent of protein. These analyses indicate that the grasses are near enough alike to be of equal feeding value. The verdict of the feeder, however, is in most cases to be taken in preference to that of the chemist, and it is doubtful whether brome-grass will ever be considered quite equal to timothy as feed for stock.

Brome-grass is usually ready to cut for hay from the last of June until the 20th of July, depending on the locality. When conditions are favorable, it is possible to secure two cuttings, the first about

the last of June or early in July, and the second in September. The securing of two crops depends almost entirely on the amount of moisture and very little on the latitude, since in eastern Manitoba two are frequently obtained. Except under irrigation, only one cutting can usually be secured in the western part of the Dakotas or at the same longitude in Canada. The first cutting yields more and is of much the better quality. The second cutting, although nearly as tall as the first when cut, consists mostly of leaves and makes very light hay.

The hay does not cure as easily as timothy and darkens rapidly if allowed to get wet. Although this makes it unsalable, its feeding value is not seriously impaired. Even when properly cured, however, the hay is of darker color than timothy.

Stacking is done with the ordinary hay-making machinery, and when put up with reasonable care the stacks shed water well and will keep for two years in excellent condition, with but a small quantity of damaged hay on the outside. (See Pl. II, fig. 2.)

As previously stated, in the third season of growth the maximum yield is usually secured. After two crops are obtained the yield rapidly diminishes. The average yield for the time the meadow is profitable, which is three or four years, may be conservatively estimated at 1½ tons per acre. This is the estimated average yield for the entire region. On good soil and under favorable conditions yields as high as 3 to 4 tons are not uncommon, especially when two cuttings a year can be secured.

Brome-grass hay is very little known on the city market and the demand for it is entirely local. It commands a good price in sections where it is grown, and ordinarily sells for $2 to $3 a ton more than native wild hay and for about the same price as timothy.

SEED.

There is a considerable quantity of brome-grass seed produced throughout the entire region under discussion, although it is grown to the largest extent in the eastern part of the Dakotas, in Manitoba, and in eastern Saskatchewan. The growing of seed in large quantities seems to have been more of an industry a few years ago than it is at the present time. It should not be inferred from this that the total quantity produced is not as great as heretofore, but that farmers are growing it less for wholesale market and more for local use, making its production more generally distributed. Whether there is actually less produced it is difficult to state; there is certainly less imported than formerly. There are many farmers who have in the past grown 100 acres, and even much more, for seed who at the present time are raising little more than enough for their own use.

FIG. 1.—A FIELD OF BROME-GRASS IN NORTH DAKOTA.

FIG. 2.—STACKING BROME-GRASS IN NORTH DAKOTA.

HARVESTING THE SEED.

The seed is mature and ready to cut from July 10 to August 1, and the stage of maturity is commonly termed the "brown" to distinguish it from the "purple," or the stage when the grass is cut for hay. Harvesting the seed is a comparatively easy matter and differs very little from the harvesting of ordinary cereals. The binder and the header are both used, but the former is the most generally employed. When the binder is used the grass is usually cut as high as possible and the bundles put in long shocks to facilitate curing. They are allowed to remain in shocks until thrashed. When the grass can be cut sufficiently high a crop of hay is obtained from the stubble as soon as possible after the seed is removed. This hay is of very fair quality, as it contains a large quantity of green leaves.

While the binder is most commonly used in harvesting, heading appears to be the best method. When it is used, almost all of the grass is left for hay, which makes quite an additional yield from the meadow. After heading, the seed is put up in well-built shocks for curing, and is usually left there from ten days to two weeks or even longer. If conditions are exceptionally favorable, it is possible to thrash directly from the header box. This is not frequently done, since the thrashing machines are not usually ready at that time of the year. The stubble is cut for hay as soon as possible after heading, and yields on an average about a ton to the acre.

Occasionally the grass is cut with a mowing machine and put in ordinary stacks for thrashing. This method is not considered desirable on account of the waste and difficulty in handling.

THRASHING.

Brome-grass is thrashed with the ordinary machine having special riddles and with the wind shut off from the fan to prevent the seed from blowing over. Difficulty is often met with in getting the cleaned seed to elevate properly in the machine, and in many cases the elevator is removed and the seed delivered from the spout at the bottom of the separator. The seed is likely to contain a great amount of chaff and broken pieces of straw after thrashing. This trash is sometimes quite difficult to separate from the seed, and it is necessary to run it through a fanning mill. By withdrawing the bundles from the cylinder after the heads have been thrashed, the seed is kept comparatively free from straw and chaff. This method involves much work and is hardly practicable where a large quantity is to be thrashed.

YIELD OF SEED.

The yield of seed is so variable, depending on the climate, soil, lay of the meadow, and other factors, that it is difficult to estimate the average quantity produced to the acre. From 250 to 350 pounds is, however, a conservative estimate. Records of the Saskatchewan experimental farm show the yield of brome-grass seed there to range from 250 to 600 pounds. Experiments conducted at the Manitoba experimental farm indicate that the harvesting of a mature crop of seed materially lessens the yield of either hay or seed the following year.

On account of the close sod formed by the grass after the first year there are very few weeds present in the fields, and consequently the seed when harvested is practically free from impurities and in very few cases are there seeds of any other grasses in it. There is occasionally a very small amount of seed of the grain used as a nurse crop and a trace of cheat (*Bromus secalinus*) and slender wheat-grass (*Agropyron tenerum*). The seeds of *Bromus inermis* are very similar to those of the above species, the seeds of chess, especially, often being mistaken for brome-grass seeds. (See Pl. III.)

STRAW.

When cut with a binder, the straw after thrashing is generally stacked and used for feed. The quality varies largely with the height at which the grass is cut, the length of time it stands in the shock, and the care with which it is stacked after thrashing. If all these conditions are favorable, brome-grass straw is about equal to oat straw. At any rate, it makes very fair feed for wintering cattle, horses, and sheep.

USE IN ROTATION.

One of the objections which farmers have to brome-grass is that it is comparatively short lived and will not remain productive for hay in a meadow more than three or four years. This objection is not serious from the standpoint of crop rotation, but, on the other hand, is slightly advantageous, since there is a general tendency to grow one crop on a field for too long a period. *Bromus inermis*, however, is not looked upon by farmers as a valuable constituent in a crop rotation. This is due to the fact that it is considered difficult to eradicate, and when ordinary methods are employed it takes about two years to get it out of the field. Farmers desire something that can be disposed of easily in one year or with one plowing, and consequently are favoring slender wheat-grass (*Agropyron tenerum*), which is now coming into popularity on this account.

SEEDS OF BROME-GRASS (BROMUS INERMIS).

(Magnified six diameters.)

PREPARATION OF BROME-GRASS MEADOWS FOR OTHER CROPS.

The breaking up of a brome-grass meadow and the preparation for other crops is a very important matter. It has been found at the Manitoba experimental farm that plowing the sod after a crop of hay has been cut and the aftermath has made a growth of 3 or 4 inches gives very satisfactory results. The plowing may be done the latter part of June or the first of July and the sod back-set either in the fall or early in the spring and put in condition for wheat or other grains by disking and harrowing. If the aftermath is allowed to grow to the extent above indicated, it assists very materially in rotting the sod and also supplies additional humus. When the breaking is done immediately after a crop of hay or seed is harvested, the sod does not rot well, especially if the season is dry, and consequently the ground is in poor condition for a crop the following spring.

A method which has been found to be practicable, at least in the eastern portion of the Dakotas, is to break early in the spring after the grass gets a good start, then disk and roll thoroughly, and in June sow to flax at the rate of about half a bushel to the acre. In this case, unless the flax makes a good stand there will be some danger of the brome-grass making a sufficient growth to become troublesome. Where flax is a successful crop, it can follow brome-grass to good advantage. No matter what method is practiced, the grass is likely to give trouble the first season on account of its persistence, but if properly handled will not be a serious menace. It is necessary in the drier sections to break the sod when the moisture conditions are favorable, whether in fall or spring, as it is very difficult to break and does not rot readily. On account of the latter fact the sod requires considerable working in the sections of low rainfall.

MISCELLANEOUS USES.

The aggressive nature of brome-grass fits it for certain uses and situations for which the common standard grasses are not adapted. It is very valuable for putting heavy new land in condition for other crops. The rich heavy soil of river bottoms, which are frequently covered with a dense growth of weeds and brush, may be put in good condition by seeding heavily after clearing and plowing. At the end of two years the grass comes on to the exclusion of the weeds and makes an excellent hay meadow.

There are certain classes of soil that after having been plowed for five or six years become very loose and blow badly and are in poor mechanical condition for ordinary crops. When *Bromus inermis* is grown on such land for a few years it adds a sufficient amount of

humus to the soil to return it to good condition. The grass is also very valuable for preventing sandy land from blowing.

Brome-grass is an excellent crop for combating such weeds as foxtail, or squirrel-tail (*Hordeum jubatum*), and on moist land, where the latter flourishes, the former excludes it very effectually.

THE AGRICULTURAL EXTENSION OF BROME-GRASS.

Little has been done in the matter of extending the growing of *Bromus inermis* farther east at the same latitude as its present region. Experiments that have been conducted with it in various sections east of Minnesota and north of Kansas indicate that it is worthy of extension. It will doubtless prove valuable on sandy soil in Wisconsin, New York, and New England, but will probably be of use mostly as a pasture grass and in mixtures with other grasses. In parts of Ohio, West Virginia, Pennsylvania, Maryland, and Virginia where tested it has shown considerable promise. South of these States it is of questionable value.

Brome-grass should be given a thorough test as a sand-binding grass along the Lakes and near the seacoast, as its extensive root system and its ability to thrive on sandy land make it well adapted to such situations. Some very striking results have been obtained with it on sandy soil on the upper peninsula of Michigan. Under similar conditions in Wisconsin its value, especially as a pasture grass, has been quite thoroughly demonstrated. In these States it is said to be at least ten days earlier for pasture in the spring than the ordinary standard grasses.

While the thorough testing of brome-grass by farmers in the States mentioned is strongly urged, its use on a large scale is not considered advisable until its value as compared with the standard grasses commonly grown in these States has been more definitely demonstrated.

SUMMARY.

Brome-grass (*Bromus inermis*) is at present of most importance in the Dakotas and sections adjoining these States, but is grown to some extent throughout the general region from Kansas north to the Canadian boundary and west to the Pacific coast. Its importance in the timothy region is as yet very limited.

It is the common practice to sow the seed in the spring about the 1st of April, or as soon as the weather is favorable. One bushel of 14 pounds is considered a sufficient quantity to produce a satisfactory stand, and good results are obtained with 10 to 12 pounds. Heavier seeding is recommended in sections where the grass is being tested or where it is intended for pasture alone.

Under ordinary conditions a brome-grass meadow remains productive from three to four years, after which it becomes what is commonly called "sod-bound." The meadow can be successfully renewed by breaking the sod lightly, the time of breaking depending largely on the annual rainfall.

Mixtures of brome-grass with other grasses and clovers have proved very satisfactory as far as they have been tried. Timothy, slender wheat-grass, orchard grass, meadow fescue, alfalfa, and red clover are used in these mixtures.

Brome-grass is a valuable general-purpose grass, but is much better adapted for use as pasture than for hay, as it furnishes a large amount of grazing, especially in the spring and late in the autumn. The yield of hay which it produces is good and the quality very satisfactory.

The seed habit of brome-grass is good, which makes it comparatively easy to harvest and thrash. Average yields of about 300 pounds to the acre are obtained.

In crop rotation brome-grass has not as yet become well established, and by some it is looked upon rather unfavorably on account of being somewhat difficult to get out of the land. Good crops, however, are raised after it, and it adds a considerable amount of humus to the soil.

It is often difficult to prepare brome-grass sod for succeeding crops, as it does not rot readily, and for this reason it is necessary to backset after breaking. The time of breaking depends on the rainfall.

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U. S. DEPARTMENT OF AGRICULTURE.

BUREAU OF PLANT INDUSTRY— BULLETIN NO. 111.

B. T. GALLOWAY, *Chief of Bureau.*

MISCELLANEOUS PAPERS.

I. THE LARKSPURS AS POISONOUS PLANTS.
By ALBERT C. CRAWFORD, *Pharmacologist, Poisonous-Plant Investigations.*

II. THE FIBERS OF LONG-STAPLE UPLAND COTTONS.
By H. A. ALLARD, *Scientific Assistant, Cotton Breeding Investigations.*

III. IMPORTED LOW-GRADE CLOVER AND ALFALFA SEED.
By EDGAR BROWN, *Botanist in Charge of Seed Laboratory,* and MAMIE L. CROSBY, *Assistant, Seed Laboratory.*

IV. FORAGE CROPS FOR HOGS IN KANSAS AND OKLAHOMA.
By C. E. QUINN, *Scientific Assistant, Farm Management Investigations.*

V. THE CULTURE AND USES OF BROME-GRASS.
By R. A. OAKLEY, *Assistant Agrostologist, Forage Crop Investigations.*

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1907.

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By R. A. OAKLEY, *Assistant Agrostologist, Forage Crop Investigations.*

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[a] The five papers constituting this bulletin were issued in separate form on July 6, September 9, October 31, December 7, and December 28, 1907.

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MISCELLANEOUS PAPERS.

THE LARKSPURS AS POISONOUS PLANTS.[a]

By Albert C. Crawford, *Pharmacologist, Poisonous-Plant Investigations.*

INTRODUCTION.

Throughout the United States many species of larkspur (Delphinium) occur. Some of these form an important feature of the western landscape;[b] others, such as *Delphinium ajacis*, on account of their beauty have been cultivated in gardens, from whence they have escaped and become a pest to the farmer.[c]

The genus Delphinium is in a very confused condition botanically and needs revision.[d] However, the botanical characteristics of the genus are clearly marked and constitute sufficient reason for considering any plant bearing them as deserving of suspicion. *Delphinium trolliifolium* Gray, represented in the accompanying illustration (Plate I), shows these characteristics. In Canada[e] and in our Western States, especially in Colorado and Montana, various species of Delphinium have been accused of stock poisoning, although feeding experiments with these plants have varied in their results, and opinion in the West has been by no means uniform as to their poisonous properties. According to Wilcox,[f] in Montana 600 sheep were poisoned by *Delphinium menziesii* on one ranch, of which 250 died. In India the

[a] Of the many kinds of plants of the western ranges poisonous to stock, various species of larkspur are among the most destructive, especially in the mountainous regions of Colorado, Wyoming, and Montana.

About two years ago a study of the poisonous properties of one of the most common species was undertaken cooperatively by the Colorado Agricultural Experiment Station and the Office of Poisonous-Plant Investigations, the field collections and field tests being carried on by Dr. George H. Glover, veterinarian of the station, and the technical laboratory studies by Dr. A. C. Crawford, Pharmacologist, under the direction of Dr. R. H. True, Physiologist in Charge of the Poisonous-Plant Investigations of the Bureau of Plant Industry. The principal results of Doctor Crawford's work are here summarized.

It is shown that this larkspur is most virulent in its early stages and becomes much less active toward flowering time. The importance of the functions of elimination in bringing about recovery is also clearly indicated, and the significance of this fact in harmonizing the varying results of different investigations is pointed out.—B. T. Galloway, *Chief of Bureau.*

[b] Meehan, T. Delphinium Bicolor. Meehan's Monthly, vol. 12, p. 1. 1902.

[c] Rept. Comr. Agr. for 1865, p. 510.

[d] Huth, E. Monographie d. Gattung Delphinium. Bot. Jahrb., vol. 20, p. 322. 1895.

[e] Noxious Weeds and How to Destroy Them. Government of Northwest Territory, Dept. Agr. Bul. 2, p. 27. 1900.

[f] Chesnut, V. K. Preliminary Catalogue of Plants Poisonous to Stock. Ann. Rept. Bur. Animal Ind., 1898, p. 400.

dew from *D. brunonianum* is said to poison stock, and *D. restitum* is claimed to be poisonous to goats.[a] Similar reports come from France.[b] Chesnut and Wilcox, in particular, have brought this subject to public attention, Wilcox's field notes and post-mortem records being especially suggestive.[c]

The main symptoms seen in the poisoning of sheep by *Delphinium menziesii* were a stiffness of the limbs, with awkward gait; associated with this were involuntary muscular twitchings and loss of muscular coordination. Convulsions with marked rapidity in the pulse rate occurred. The respiration became shallow, but finally rapid. Wilcox fed the chloroform and benzol extracts of the dried plant to sheep, causing typical symptoms. He also called attention to larkspur poisoning in cattle.[d] This work was continued by Chesnut and Wilcox.[e] They fed and injected extracts of tall larkspur (*Delphinium glaucum*) and of purple larkspur (*D. bicolor*); but although these extracts produced some symptoms in rabbits and in sheep they failed to kill.

Nelson pastured a sheep during May in an area in which *Delphinium menziesii* was growing. This sheep ate all the Delphinium she could obtain herself, and in addition was fed 1,133.92 grams more, but showed no symptoms. A second sheep was fed 1,111.3 grams of the fresh plant in five days, but showed no symptoms. During the experiment this animal was deprived of all feed save the Delphinium.[f] Irish[g] experimented by feeding the plants growing in May to steers, feeding the tops of 24 plants of *D. trolliifolium* to one and the roots to another without results. He also fed 30 plants of white larkspur without results. He fails to state, however, how long his feeding continued. Glover's experiments[h] with rabbits were rather misleading, some dying, but most survived. Gerlach[i] fed *D. consolida* to sheep without results.

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[a] Watts, G. Dictionary of Economic Products of India, vol. 3, pp. 64, 70. 1890.

[b] Delaford, P. Traitê sur la maladie de sang des bêtes à laine, Paris, 1843, p. 173.

[c] Wilcox, E. V. Larkspur Poisoning of Sheep. Montana Agr. Expt. Sta. Bul. 15. 1897.

[d] Wilcox, E. V. Poisonous Plants of Montana. Montana Agr. Expt. Sta. Bul. 22, p. 45. 1899.

[e] Chesnut, V. K., and Wilcox, E. V. Stock-Poisoning Plants of Montana. U. S. Dept. Agr., Div. Botany, Bul. 26, p. 65. 1901.

[f] Nelson, S. B. Feeding Wild Plants to Sheep. Proc. Sec. Ann. Meeting Assoc. Expt. Sta. Veterinarians. 1898. U. S. Dept. Agr., Bur. Animal Ind., Bul. 22, p. 11.

[g] Irish, P. H. Plants Poisonous to Stock. Oregon Expt. Sta. Bul. 3, p. 25. 1889.

[h] Glover, G. H. Larkspur and Other Poisonous Plants. Colorado Agr. Expt. Sta. Bul. 113, p. 17. 1906.

[i] Dammann, C. Gesundheitspflege, 1886, p. 841.

DELPHINIUM TROLLIIFOLIUM, GRAY.

LABORATORY EXPERIMENTS WITH DELPHINIUM CAMPORUM.

Specimens of *Delphinium camporum* were sent from Fort Collins, Colo., for testing in the laboratory of Poisonous-Plant Investigations. Five grams of the dried and powdered plant were accurately weighed and then extracted over night with 20 c. c. of water and 10 c. c. of 95 per cent alcohol. The alcohol was added mainly as a preservative. The following day the extraction and squeezing were continued until the fluid became colorless. The fluid was evaporated on the next day in vacuo at about 40° C., and the residue was dissolved in water and made up to 30 c. c.—perfectly arbitrary figures. Of this aqueous solution 1 c. c. injected subcutaneously into a guinea pig weighing 730 grams caused no disturbance, and 3 c. c. were also without effect, whereas 6 c. c. killed the same guinea pig in 55 minutes. A solution of 4 c. c. injected into a guinea pig weighing 352 grams caused no symptoms, while 6 c. c. injected into another guinea pig weighing 285 grams killed in 33 minutes. Later, 5 c. c. killed a guinea pig weighing 196 grams in 55 minutes, while 4 c. c. injected into a guinea pig weighing 299 grams gave no symptoms. Evidently the lethal dose of this solution lies between 4 and 5 c. c. The solution used in the above experiments was made from plants collected on April 26, 1905.

On May 16 another lot of material was collected, and a solution corresponding to 4 c. c. of the first batch was injected into a guinea pig weighing 455 grams without producing any symptoms. However, 5.3 c. c. of this solution killed a guinea pig weighing 350 grams, but a much longer period elapsed before death occurred than with the extract of the first material.

In June another lot of material was collected, and a solution of this corresponding to 4 c. c. caused no symptoms in a guinea pig weighing 376 grams; 5.3 c. c. caused no symptoms in a guinea pig weighing 500 grams, and 6.6 c. c. was inactive in a guinea pig weighing 480 grams. Of the dried material 10 grams were then extracted, and killed a guinea pig weighing 320 grams only after about 10 hours. A control amount of plain distilled water failed to kill. The lethal dose is evidently much higher than in the second stage.

There is no question as to the fact that Delphinium when injected subcutaneously will kill, and these experiments also establish the fact that the plant loses much of its toxicity as it approaches the flowering stage. It has been noted that *Delphinium consolida* is also less active when mature.[a]

Just after flowering, the purple larkspur turns yellow and ceases to

[a] Dammann, C. Gesundheitspflege, 1886, p. 1072.

be attractive, so that there is less danger of poisoning,[a] although Chesnut and Wilcox report a death in cattle from eating *Delphinium glaucum* in September.[b] The great danger early in the season seems to arise from the fact that the Delphinium appears early in the spring, and the ground may again be covered with snow, so that it is the only green plant in sight, and therefore when in an especially poisonous stage it is eaten by cattle.

A rabbit weighing 2,409.66 grams was fed January 28, 1907, with a concentrated aqueous extract corresponding to 16.66 grams of the dried plant in the second stage. No symptoms resulted. On January 30 the animal weighed 2,377.15 grams.

On January 28, 1907, a second rabbit, weighing 1,658.35 grams, was fed with a similar extract of 33.33 grams, but no symptoms resulted. Two days later the animal still weighed 1,658.35 grams.

On February 1, 1907, the first rabbit was fed an aqueous extract of 80 grams, and it died in 53 minutes with convulsions. Previous to death, paralysis of the voluntary muscles was well marked. The stomach of this animal was markedly reddened.

A rabbit weighing 1,984.41 grams on February 6, 1907, was starved 24 hours and then fed an extract of 50 grams of the same plant at 9.45 a. m. At 11.50 a. m. the animal was dull and was lying with its chin resting on the floor; at 12.25, legs paralyzed; 3.04, the animal urinated, chin still resting on the floor; 3.57, the animal could push itself around with hind legs. The following day the rabbit appeared normal. On February 11 it weighed 1,899.39 grams; February 12, 1,956.07 grams; February 13, 2,012.75 grams; March 11, 1,984.41 grams.

On February 13, 1907, a well-fed rabbit, weighing 2,097.77 grams, which had been in the laboratory for some time, was fed by stomach tube an aqueous extract of 50 grams of the same plant. This animal was observed continuously for 6 hours and appeared perhaps only slightly duller. He ate during the night, and weighed 2,119.94 grams on February 14. During the night no stools were passed. On February 16 this rabbit weighed 1,970.24 and on February 21, 2,012.75 grams.

The urine passed the first 24 hours after feeding was alkaline. Some of this was shaken with chloroform and on evaporation was taken in acid water. On evaporating off the acid, the watery solution was injected subcutaneously into a guinea pig weighing 467.76 grams, but produced no symptoms. The urine secreted in the following 24

[a] Wilcox, E. V. Plant Poisoning of Stock in Montana. U. S. Dept. Agr., Bur. Animal Ind., 17th Ann. Rept., 1900, p. 96.

[b] Chesnut, V. K., and Wilcox, E. V. Stock-Poisoning Plants of Montana, p. 67.

hours was added to the first and the whole shaken out with benzol. This, after taking up with acid water, was injected into the same guinea pig. The animal soon became very dull, walking with waddling gait when forced to move, being evidently affected by the poison. Two days later the animal was normal. The urine of a control rabbit, similarly shaken with benzol, produced no such symptoms in this guinea pig.

On February 11, 1907, an aqueous extract of 5 grams was injected subcutaneously into a rabbit weighing 666.14 grams. An hour and three minutes later the animal was unable to stand, and soon developed convulsive movements of the limbs. This animal was expected to die at any time during the afternoon, but gradually improved and appeared slightly duller than normal the following day. On February 13 it weighed 613.61 grams; February 25, 595.29 grams; and on March 16, 552.78 grams, showing a steady diminution in weight.

An extract of 9.5 grams injected subcutaneously into a rabbit weighing 2,182.79 grams was without immediate effect.

An aqueous extract of 20 grams when injected into a rabbit weighing 481.93 grams soon caused paralysis of the limbs, and the rabbit died in 32 minutes.

On February 11, 1907, a rabbit weighing 1,417.46 grams was opened under ether, and the mouths of the ureters were tied off, together with the bladder, to prevent elimination by the urine. An aqueous solution corresponding to 34 grams of the same plant was then fed by mouth. This animal remained dull all the afternoon, and at 4.45 p. m., 4 hours and 45 minutes after the feeding, he was resting with his chin on the cage. He was found dead and stiff at 9.15 p. m., having evidently died some time previous. A post-mortem showed the ureters distended and sharply outlined.

Another rabbit weighing 1,743.37 grams was prepared in a similar manner by tying off the ureters and bladder and was fed with an extract of 50 grams. In 1 hour and 47 minutes this animal was paralyzed and unable to stand, breathing very slowly, and died 6 minutes later. The ureters were found dilated as in the previous case, and the stomach was slightly reddened.

A control for these two rabbits was prepared in a similar manner at the same time as the others. Nine hours after the operation, when the two rabbits which were fed the Delphinium were dead, this rabbit was bright and running about, but was then killed with chloroform to prevent suffering.

In these cases it is necessary to consider not only the effects of nonelimination but also the fact that the power which the liver possesses of storing up and removing injurious bodies from the circulation may

be interfered with, as Mosse[a] has proved that starved and nephrectomized rabbits show histological changes in the liver cells.

On February 20, 1907, a well-fed rabbit weighing 1,403.29 grams was etherized for 12 minutes and then fed an extract of 50 grams to see if the increased toxic action of the plant was due to any interference with the metabolism caused by the ether. On February 23 this animal showed no symptoms, weighing 1,360.78 grams, and on February 25 the weight was 1,403.29 grams. The urine collected in 60 hours was shaken with benzol, as it had previously been found that much, if not all, of the active principles of *Delphinium camporum* goes into the alkaline benzol shaking by the Dragendorff method. The residue from the benzol evaporations was then taken up with acetic acid water. On removing the acid by heat a few drops were injected into the dorsal lymph sac of a male frog (*Rana clamitans*) weighing 35 grams. This animal soon became paralyzed and was unable to move, but recovered over night. The following day a few more drops were injected with the same result, showing that some of the active principle of the Delphinium was eliminated with the urine.

From these experiments it can be seen that aqueous extracts of *Delphinium camporum* will kill rabbits on subcutaneous injection, and also by mouth if the dose is large, while much smaller doses will kill if the elimination is interfered with, as by tying off the ureters, or after starving, a condition which intensifies the action, probably by accelerating absorption. What seems to be the cause of the uncertainty in the results, especially in the lack of striking results in the feeding experiments, is that no consideration was given to the fact that the poisoning in this case may be simply the resultant of the excretion and absorption of the plant; in other words, that very little of the plant may be taken up by the gastro-intestinal tract and that this may be eliminated by the kidneys before a poisonous dose has been absorbed, so that the question of poisoning becomes one of rapidity of absorption. This is well known to be the case with curare, where the administration by mouth, except in large doses, is not likely to prove poisonous unless the elimination is interfered with as by tying the ureters.[b] Consequently the conditions most favorable for poisoning on the range would be those which aid the more thorough extraction of the poisonous principle from the plant by the gastro-intestinal tract, thus favoring absorption, and those which interfere with the elimination by the kidneys or interfere with the storing of the poison by the liver, as renal and hepatic disease or lack of salts, which normally increase diuresis.

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[a] Mosse, M. Ueber Leberzellenveränderungen nephrektomierter u. hungernder Thiere. Zeits. f. Klin. Med., vol. 60, p. 373. 1906.

[b] Brunton, T. L. Text-Book of Pharmacology, 3d ed., London, 1893, p. 38.

A striking feature about these rabbits is that in some cases while the dose was not sufficient to kill immediately they gradually lost in weight, probably a direct result of the irritation of the gastro-intestinal tract. This condition may find its parallel in stock removed from a Delphinium area. Knowles[a] and Wilcox[b] have claimed that the inhalation of a few drops of ammonia and the hypodermic injection of atropin, $\frac{1}{60}$ to $\frac{1}{4}$ gram (1 mg. to 15 mg.) for sheep, or 1 gram (60 mg.) for cattle, is the most effective medicinal treatment. Elimination by purgatives and diuretics may aid. If possible, absorption from the gastro-intestinal tract should be hindered, perhaps by lard, but the real treatment is preventive.

One member of the genus Delphinium, *D. staphisagria*, has been studied carefully, and a number of bases (delphinin, delphinoidin, staphisagrin) isolated, but much is still to be desired in the way of exact knowledge concerning these bodies.[c] Delphinin has a local irritative action. Its systemic action is mainly paralytic on the heart and respiration, and resembles that of aconitin in many respects.[d] Post-mortem examinations in poisoning by mouth with this body showed marked reddening of the stomach. In a number of Van Praag's experiments with feeding solutions of Delphinium a marked increase in urinary secretion was noted.[e] *Delphinium consolida* has also received some attention chemically,[f] while *D. leroyi*, *D. peregrinum*, and *D. mauritanicum* have been shown to produce poisoning experimentally.[g]

Recently *Delphinium bicolor*, *D. menziesii*, *D. nelsonii*, and *D. scopulorum stachydeum* have been found to yield an alkaloid, delphocurarin,[h] which has been introduced as a substitute for curare in

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[a] Knowles, M. E. Larkspur Poisoning in Sheep and Cattle. New York Med. Jour., vol. 66, p. 271. 1897.

[b] Wilcox, E. V. Larkspur Poisoning of Sheep, p. 45.

[c] Dragendorff and Marquis. Ueber d. Alkaloide des Delphiniums staphisagria. Arch. f. Exp. Path. u. Pharmakol., vol. 7, p. 55. 1877.

Kara-Stojaiow, C. Ueber d. Alkaloide d. Delphinium staphisagria. Pharm. Zeits. f. Russland, 1890, vol. 29, pp. 628, 641, 657, 673, 689, 705, 721.

[d] Tamburini, N., and Leone, A. Azoine fisiol. della Delfinina. Gior. Internaz. d. Sci. Med., n. s., vol. 3, p. 985. 1881.

Orfila, M. Traité de toxicologie, 5 ed., vol. 2, p. 138. 1852.

[e] Van Praag, J. L. Delphinin. Arch. f. Path. Anat., vol. 6, p. 439. 1854.

Sereck, J. Beitr. z. Kennt. d. Delphinins. Dorpat Diss. 1874.

Darbel, A. Recherch. Chim. et physiol. sur les alcaloides du Delphinium staphisagria. Montpellier. Thèse. 1864.

[f] Masing, E. Ueber d. Alkaloid d. Feldrittersporns. D. consolida. Pharm. Zeits. f. Russland, vol. 22, p. 33. 1883.

[g] Rochebrune, A. T. de. Toxicol. Africane, vol. 1, pp. 152, 161, 353. 1896.

[h] Feinde der Haustiere und ihre giftige Principen (Delphocurarin). Pharm. Centr., vol. 44, p. 913. 1903.

vivisection work, and this introduction is indorsed by Lohmann's work.[a]

Schiller[b] corroborates Lohmann's results, but claims that curare is efficient for muscle physiological work in smaller doses than is the delphinin of Heyl.

This use of Delphinium certainly offers a field which should be investigated commercially, as curare is likely to be uncertain in its action.[c] Methyl delphinin is said also to possess this curare-like action.[d]

The coloring matter of the flowers of *Delphinium zalil* has been utilized as a dye.[e] Other Delphiniums, such as *D. ajacis*, have been recommended for insecticidal uses, and especially on account of cheapness.[f]

Froggatt states that common garden larkspur will kill locusts, and advises planting them in masses around gardens and orchards to protect against the ravages of these insects.[g] The same claim is made as to its action against grasshoppers.[h]

Delphinium coeruleum has been used to kill maggots and *D. brunonianum* to destroy ticks.[i] This latter plant has been used to some extent as a substitute for musk.

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[a] Lohmann, A. Unters. über d. Verwerthb. eines Delphinin präp. an Stelle d. Curare in d. muskelphys. Technik Pflüger's Arch. f. Ges. Physiol., vol. 92, p. 473. 1902.

[b] Schiller, V. Ueber d. physiol. Wirkungen d. Delphinins (Heyl). Arch. f. Anat. u. Physiol., Physiol. Abtheil., p. 248. 1904.

[c] Merck, E. Ann. Reports, 1902, vol. 16, p. 48.

[d] Kobert, R. Lehrb. d. Intox., 2d ed., p. 1185.

[e] Aitchison, J. E. T. Some Plants of Afghanistan. Pharm. Jour. and Trans., vol. 17, p. 466. 1887.

[f] Amer. Jour. Pharm., vol. 55, p. 50. 1883.

[g] Froggatt, W. W. Plague Locusts. Agr. Gaz. New South Wales, vol. 11, p. 181. 1901.

[h] Bailey, J. F. Hemp. Queensland Agr. Jour., vol. 2, p. 200. 1898.

[i] Watts, G. Dictionary of Economic Products of India, vol. 3, pp. 64–65. 1890.

B. P. I.—305.

THE FIBERS OF LONG-STAPLE UPLAND COTTONS.

By H. A. Allard, *Scientific Assistant, Cotton Breeding Investigations.*

UNIFORMITY OF COTTON FIBERS.

In investigations in cotton breeding where an improvement in certain lint characters is desired several factors must be carefully considered. Among these, some of the most important are fineness of lint, the relative yield of lint to the total yield of seed cotton, and the uniformity of length of all the fibers when properly combed out and examined. The last character, uniformity of length, is a most important one and has much to do with subsequent waste and the production of good yarns in the process of manufacture.

On Plate II are illustrations of cotton seeds with fibers combed out to show uniformity and nonuniformity in the length of the fibers. The seeds to the left (A) show very poor uniformity and are of the "butterfly" type, as they are commonly called. In marked contrast, the seeds to the right (B) show excellent uniformity as a result of several generations of careful selection.

APPARENT LACK OF UNIFORMITY AND ITS OCCURRENCE.

There is an apparent lack of uniformity which deserves considerable attention from the standpoint of cotton growers and breeders. Plate III illustrates this character, although it is more strikingly brought out in the operation of detaching the seed from the lock. From the illustration there would appear to be a great lack of uniformity, due to a group of fibers about twice the length of the general covering. This group arises from the center of the main body of fibers or, often, from those having a point of attachment near the larger end of the seed. This character is usually associated with the finer, more crinkly types of long-staple cottons, such as the fine, long-linted Egyptian and Sea Island varieties and the long-staple Upland varieties—Griffin, Allen, Cook, etc. It is a character which becomes more apparent as a variety is being rigidly selected generation after generation for finer, longer staple. This has been well illustrated in the improvement of the lint characters of the Russell variety and, to some extent, the Jones variety. The orginal condition

of both of these varieties is remarkably free from this so-called longer group of fibers. In the case of the greatly improved Russell strain, which has become distinctive enough in good lint characters and yield to be designated as a new variety—the so-called Columbia cotton—these longer fibers are evident to a remarkable degree.

THE TRUE NATURE OF THE LONGER FIBERS.

It has been more or less the rule with cotton breeders and cotton growers acquainted with the requisites of desirable lint characters to regard these extra-long fibers as an unfavorable feature. In this light they meant a variation toward nonuniformity. In the work of selection, to avoid as much as possible a perpetuation of this sort of variation, plants showing this character most markedly were regarded with suspicion and later even discarded, although in other respects they were among the best in the field.

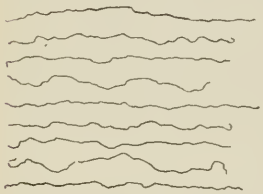

FIG. 1.—Single cotton fibers from the so-called longer group of fibers.

A careful examination leads to the conclusion that these fibers should be regarded in a wholly different light. *They are not longer fibers as they have been generally considered, but are caused by more or less curling and interweaving, which results in the pulling out of fibers from adjacent seeds.*

In the ordinary manner of stretching the locks to determine the drag, the fibers are slowly separated and drawn out, and at those points of greatest binding, as shown in Plate II, C, *a*, *b*, and *c*, the groups of longer fibers appear to rise. If, now, a single seed is selected and detached from the rest and the entire group of fibers loosened from its attachment to the seed coat in the neighborhood of the longer groups, one can with fine forceps draw these fibers out carefully and compare their length with those of the rest of the seed.

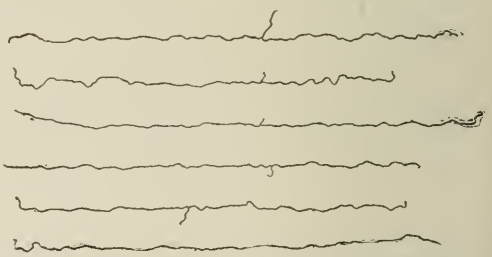

FIG. 2.—A few extra-long cotton fibers, showing two fibers united.

In many instances the single fibers now readily separate, since the tension of pulling has ceased. Several of these single fibers are shown in figure 1. In some instances fibers nearly twice the normal length are drawn out. Oftentimes with the naked eye the point of union or tying may be discerned by the tiny loose ends, as is shown in figure 2. In other cases, however, this point of union is so intimate that only a high microscopic power can make it evident. Figure 3 illustrates various

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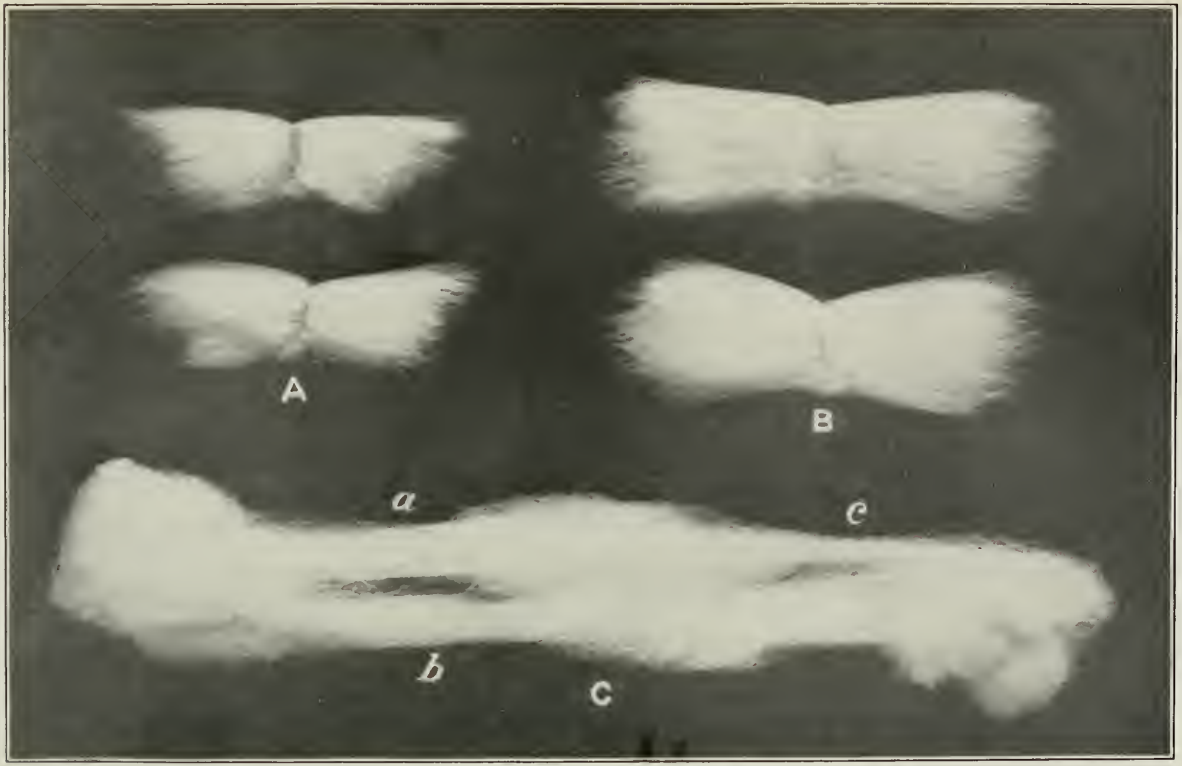
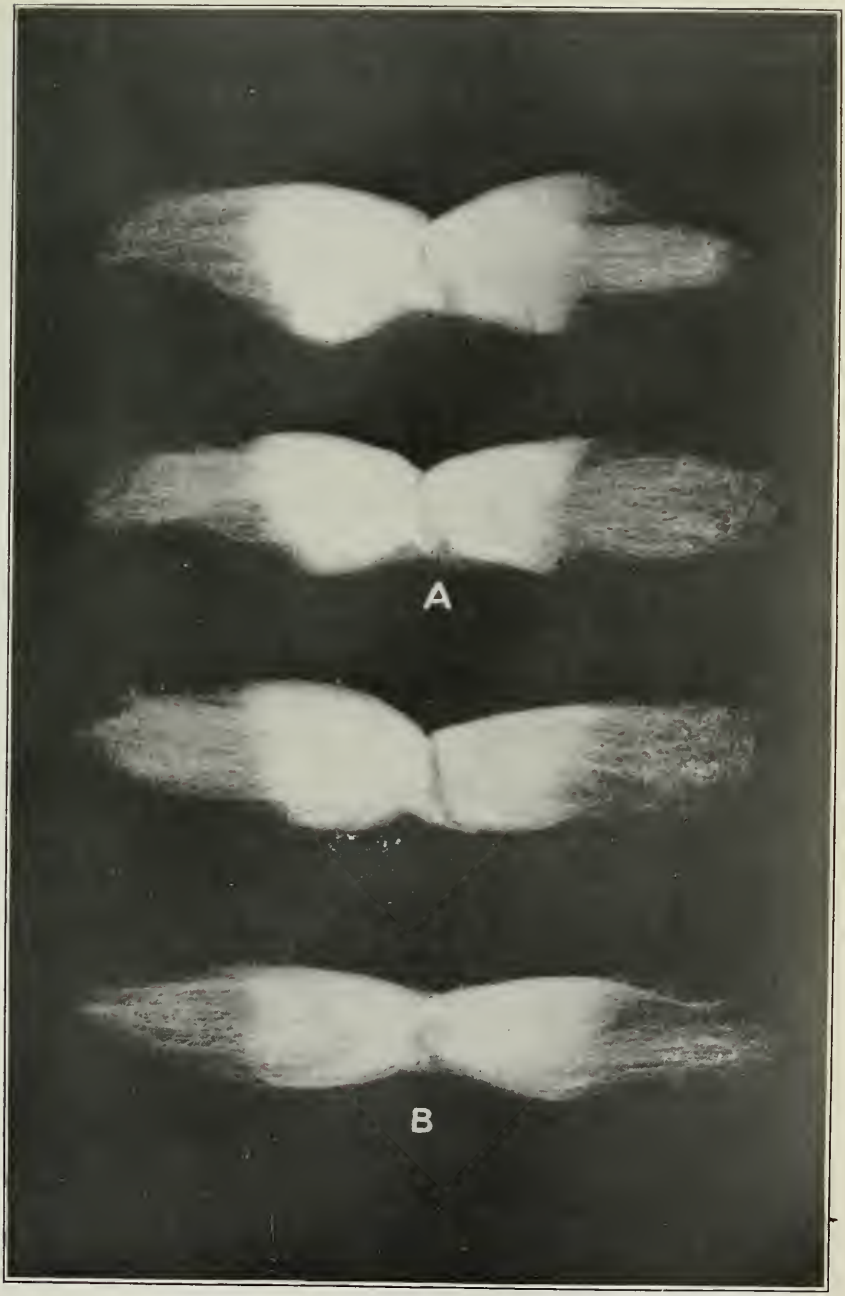


COTTON SEEDS WITH FIBERS ATTACHED.

A and *B*.—Cotton seeds with fibers combed out to show uniformity and nonuniformity in the length of the fibers. *C*.—Lock of Griffin cotton stretched so as to show points of origin of longer fibers—*a*, *b*, and *c*.



SEEDS OF COTTON COMBED OUT TO SHOW THE SO-CALLED LONGER FIBERS.

A.—Columbia variety. *B.*—Griffin variety.

degrees of this tying or curling together, as seen when greatly magnified. In figures 1 and 2 single and united fibers, respectively, of natural length are shown, but the diameters are of necessity much greater than normal, owing to the exceeding fineness of the fibers.

The drag of cottons showing the longer fibers previously described gives a more extended, elastic tension than is manifest among the short-staple varieties. It is probable that breeders may find this character a useful one in indicating a tendency toward increased length, fineness, and crinkliness of staple in the individuals in which it occurs most noticeably—an indication of better spinning quality.

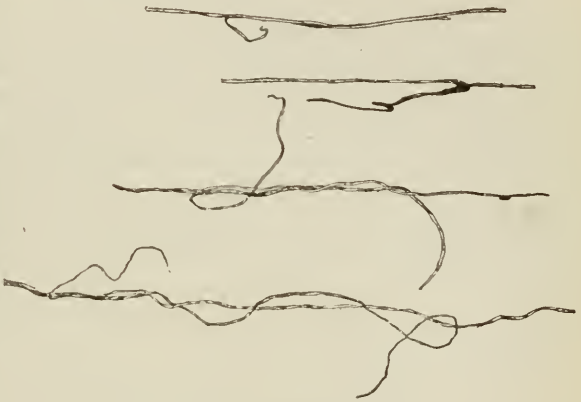


FIG. 3.—Cotton fibers tied together, very much magnified

It is important that breeders and growers of long-staple cottons should know that these apparently longer fibers are no indication of true lack of uniformity. The presence of these fibers in the long-staple Upland varieties has quite universally led to the erroneous belief that such cottons are rather inferior in uniformity as regards length of fibers. The Griffin cotton, in particular, recognized in other respects as the best long-staple Upland cotton grown, has always been described as decidedly unsatisfactory so far as uniformity in length of staple is concerned, since the drawing out of fibers from adjacent seed is a marked characteristic of this variety.

A knowledge of the true nature of these longer fibers will clear the reputation of some of the best long-staple Upland varieties of a serious fault hitherto wrongly attributed to them by all breeders and growers.

B. P. I.—311.

IMPORTED LOW-GRADE CLOVER AND ALFALFA SEED.

By Edgar Brown, *Botanist in Charge of Seed Laboratory*, and Mamie L. Crosby, *Assistant, Seed Laboratory.*

INTRODUCTION.

During the calendar year 1906 the United States exported 3,615,873 pounds of clover seed, and during the latter half of the same year imported 6,306,561 pounds, the exports for the year being only a a little more than one-half the imports for six months. The same condition holds true with alfalfa seed, the imports far exceeding the exports. The relatively large importation of these seeds results from short crops in this country and a constantly increasing demand on account of the new land being brought under cultivation and the extension of diversified farming.

Illustrations of typical samples of imported red clover and alfalfa seed of good quality and that of low grade are shown in Plate IV.

WHY LOW-GRADE SEED IS IMPORTED.

In Europe seed testing has been gradually growing in favor for forty years and is now recognized as an important aid to agriculture. All the European countries, with the exception of Spain and Turkey, have seed-testing stations, varying in number from one in Italy to twenty-eight in Germany. Each of them has the necessary equipment for making complete tests of seed, both for mechanical purity and for germination.

The test for mechanical purity as conducted in these stations includes not only the determination of the percentage of pure seed and of other seeds and dirt, but also the size and source of the seed. The source of the seed is determined by the characteristic weed seeds which are found. While errors are no doubt made, these determinations are of great value in showing that at least a part of the seed was raised in a certain section, and they furnish information as to the probable adaptability of the seed to local conditions. Through the work of these stations the people have come to appreciate the importance of good seed, and as the greater part of that now used in Europe is sold on the basis of accurate tests for mechanical purity and germination the sale of low-grade seed has been greatly reduced.

A similar condition exists in Canada, where there is a strict law governing the quality of seed sold. In this country, however, only

three States have any effective legislation restricting the sale of seeds within their borders. Several of the agricultural experiment stations are preparing to undertake seed testing, but their equipment is limited and the number of samples handled is small. At present there are no Federal restrictions on the importation of low-grade and worthless seed. As a natural result the United States has become the dumping ground for the poor seed of Canada and Europe.

ANALYSES OF IMPORTED LOW-GRADE SEEDS.

RED CLOVER.

Table I gives the analyses of sixty-one lots of low-grade red clover seed imported during the fiscal year ended June 30, 1906, amounting to 990,809 pounds. The total importations of red clover seed for the same period amounted to 7,498,287 pounds, so that the low-grade seed furnished about one-eighth of the total. These low-grade importations contained seed enough to sow approximately 125,000 acres at an average rate of seeding. This seed is for the most part small-sized, light-weight screenings. A practical failure must be expected whenever seed of this quality is used, either from not securing a stand on account of poor germination or from smothering with introduced weeds.

TABLE I.—*Analyses of 61 samples of low-grade red clover seed imported during the year ended June 30, 1906.*

Number of seed sample.	Red clover seed.	Other seeds.	Dirt and broken seed.	Dodder present.[a]	Kinds of weed seeds.	Weight of 1,000 red clover seeds.	Germination of red clover seed.	Quantity imported.[b]	Price per 100 pounds at which seed was imported.	Live red clover seed (seed that germinated) in sample.	Actual cost of 100 pounds of red clover seed that germinated.
	Per cent.	*Per cent.*	*Per cent.*		*Number.*	*Milligrams.*	*Per cent.*	*Pounds.*		*Per cent.*	
2945	48.06	25.78	26.16	No.	39	882	38	6,740	$5.20	18.26	$28.48
2946	66.1	13.16	20.74	Yes	27	900	91	5,027	7.60	60.15	12.63
2947	77.43	9.44	13.13	Yes	32	1,135	83	6,876	9.10	64.27	14.16
3101	72.5	25.73	1.77	No.	10	1,594	96.5	3,750	11.00	69.96	15.72
3159	73.14	10.38	16.48	Yes	25	893	88.5	16,535	8.00	64.73	12.36
3222	73.8	7.88	18.32	Yes	24	810	89	13,380	7.20	65.68	10.96
3395	70.41	10.90	18.69	Yes	20	779	76.5	30,857	7.00	53.86	12.99
3400	75.78	9.35	14.87	Yes	28	895	80	32,706	7.75	60.62	12.78
3425	70.05	21.89	8.06	No.	33	1,377	77.5	32,630	8.00	54.29	14.73
3432	74.39	15.02	10.59	Yes	50	951	75.5	22,000	8.00	56.16	14.24
3456	43.03	19.31	37.66	Yes	39	855	28.5	25,300	2.80	12.26	22.84
3457	46.24	19.09	34.67	Yes	32	818	27.5	35,347	6.10	12.72	47.95
3488	63.31	23.22	13.47	No.	29	913	68	35,350	5.80	43.05	13.47
3566	69.81	12.25	17.94	Yes	23	847	72	32,893	7.50	50.26	14.92
3571	67.89	16.67	15.44	No.	29	995	66.5	29,490	9.20	45.15	20.37
3587	67.55	13.50	18.95	Yes	45	898	60.5	7,015	7.10	40.87	17.37
3588	76.74	14.53	8.73	Yes	39	952	63.5	12,498	7.60	48.73	15.59
3591	70.6	12.59	16.81	Yes	30	839	21.5	13,119	3.50	15.18	16.27
3598	74.73	12.68	12.59	Yes	40	1,102	75.5	33,069	8.25	56.42	14.62
3647	64.84	11.69	23.47	Yes	32	885	68	32,562	7.70	44.09	17.46
3696	64.09	13.79	22.12	Yes	36	840	62.5	44,029	11.50	40.05	28.71
3721	72.55	20.67	6.78	No.	19	1,143	75.5	32,523	7.60	54.77	13.88
3755	65.65	18.48	15.87	No.	33	885	52.5	6,550	5.50	34.47	15.96
3810	65.52	19.23	15.25	Yes	23	977	48.5	15,588	6.40	31.78	20.14

[a] 75.41 per cent of samples contained dodder.
[b] Total quantity of low-grade red clover seed imported, 990,809 pounds.

FIG. 1.—ALFALFA OF GOOD QUALITY.
Natural size and magnified 9 times.

FIG. 2.—IMPORTED ALFALFA OF LOW GRADE.
Natural size and magnified 9 times.

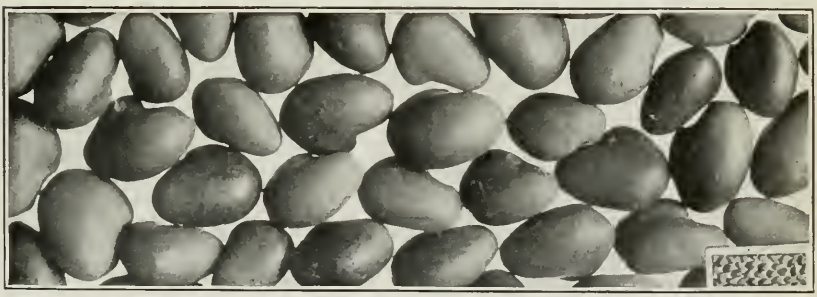


FIG. 3.—RED CLOVER OF GOOD QUALITY.
Natural size and magnified 9 times.

FIG. 4.—IMPORTED RED CLOVER OF LOW GRADE.
Natural size and magnified 9 times.

TABLE I.—*Analyses of 61 samples of low-grade red clover seed imported during the year ended June 30, 1906*—Continued.

Number of seed sample.	Red clover seed.	Other seeds.	Dirt and broken seed.	Dodder present.	Kinds of weed seeds.	Weight of 1,000 red clover seeds.	Germination of red clover seed.	Quantity imported.	Price per 100 pounds at which seed was imported.	Live red clover seed (seed that germinated) in sample.	Actual cost of 100 pounds of red clover seed that germinated.
	Per cent.	*Per cent.*	*Per cent.*		*Number.*	*Milligrams.*	*Per cent.*	*Pounds.*		*Per cent.*	
3811	57.3	22.81	19.89	Yes	45	1,021	42	15,506	$5.60	24.06	$23.27
3816	64.58	10.27	25.15	Yes	31	886	60.5	32,116	7.62	39.07	19.50
3834	77.45	7.70	14.85	Yes	28	1,087	66	33,159	9.60	51.12	18.78
3906	61.34	15.51	23.15	Yes	45	846	53	32,468	7.50	32.51	23.07
3945	67.04	17.10	15.86	Yes	36	891	67	12,474	8.50	44.91	18.93
3946	83.54	6.60	9.86	Yes	21	995	74	30,427	11.20	61.82	18.12
3959	94.04	.95	5.01	Yes	12	1,357	44.5	1,576	9.50	41.85	22.70
3960	94.15	1.77	4.08	Yes	19	1,552	69	11,288	9.90	64.96	15.24
3962	97.15	.66	2.19	Yes	11	1,538	34	12,000	8.60	33.03	26.04
3963	96.07	1.66	2.27	Yes	14	1,585	70	6,393	8.00	67.25	11.90
3964	96.32	1.93	1.75	Yes	11	1,603	72	5,952	9.10	69.35	13.12
3965	93.54	.27	6.19	Yes	9	1,422	15	2,425	4.50	14.03	32.07
3967	95.04	1.20	3.76	Yes	17	1,404	48	7,937	7.60	45.62	16.66
3994	47.49	32.08	20.43	Yes	41	909	17.5	10,995	4.70	8.31	56.56
3990	83.07	10.32	6.61	No	17	1,252	72.5	750	12.00	60.22	19.93
4009	83.87	8.02	8.31	Yes	42	1,370	46.5	11,130	8.20	38.9	21.08
4010	64.04	17.07	18.89	Yes	41	835	26	15,024	5.80	16.65	34.83
4026	68.59	17.78	13.63	Yes	20	870	86.5	4,000	14.20	59.33	23.93
4029	94.23	2.59	3.18	No	11	1,582	65.5	10,318	8.80	61.72	14.25
4031	95.41	1.76	2.83	Yes	11	1,495	54.5	2,500	8.98	51.99	17.27
4032	93.82	3.91	2.27	No	14	1,732	43.5	6,303	6.80	40.81	16.66
4035	95.52	2.16	2.32	Yes	19	1,555	27.5	3,382	7.80	26.27	29.69
4038	95.63	1.12	3.25	Yes	17	1,397	53.5	2,372	7.70	51.16	15.05
4044	67.80	14.91	17.29	Yes	43	963	31.5	32,074	7.00	21.36	32.77
4051	98.29	.41	1.3	No	5	1,597	59.5	2,551	6.90	58.48	11.79
4053	93.55	.17	6.28	Yes	8	1,434	8	1,102	4.50	7.48	60.16
4067	78.61	8.82	12.57	No	15	1,164	50	453	4.00	39.30	10.18
4084	61.09	16.93	21.98	No	19	1,236	75.5	33,866	10.10	46.12	21.90
4097	64.77	16.41	18.82	Yes	50	951	46	10,787	7.00	29.79	23.50
4118	74.04	15.18	10.78	Yes	35	1,010	60.5	2,963	7.50	44.79	16.74
4163	76.62	12.36	11.02	No	26	1,165	75.5	30,000	8.10	57.84	14.00
4165	54.44	24.57	20.99	No	37	868	38	18,200	6.00	20.68	29.01
4179	61.56	15.58	22.86	Yes	48	926	55.5	22,046	6.12	34.16	17.93
4180	61.04	12.58	26.38	Yes	27	926	75.5	4,851	7.70	46.08	16.71
4181	58.02	17.13	24.85	Yes	46	933	54	22,046	6.12	31.34	19.54
4183	77.65	8.15	14.20	Yes	38	980	87.5	7,363	9.75	67.94	14.35
4225	72.79	16.88	10.33	Yes	43	1,010	29	6,178	6.00	21.11	28.42
Average.	74.06	12.17	13.83		29.7	1,105.5	58.03	.....	7.61	43.16	20.39

In more than one-half of the sixty-one samples of which an analysis is given the weight of 1,000 seeds is less than a gram, while 1,000 good plump seeds weigh 1½ grams or more. These lots contain an average of only 43.1 per cent of live red clover seed and much of the seed that will germinate is worthless for seeding purposes, as it is of small size, immature, and of low vigor.

It is often claimed that seed of this kind is imported to be recleaned before it is put on the market. This, however, can not be the case, as in the importations referred to the average cost of the red clover seed that will grow is $20.39 per hundred pounds on the basis of the average import price of $7.61 per hundred pounds. At the time this seed was imported five lots of high-grade seed were offered for sale to the Department of Agriculture at an average price of $15.05 per hundred pounds, the average cost of the red clover seed that germinated being $15.59 per hundred pounds. In other words, one

hundred pounds of seed that would grow of the best quality cost $15.59, while one hundred pounds that would grow of the poorest quality was imported at a cost of $20.39.

This low-grade seed always carries a large number of weed seeds, fifty kinds being found in each of two lots. Of that from Germany all but five lots contained dodder seed.

In sowing seed of the average quality shown in Table I at the rate of 8 pounds to the acre there would be about nine weed seeds sown per square foot, including three dodder seeds to every 2 square feet.

Below is given the number of each kind of weed seeds found in the lots an analysis of which is given in Table I.

NUMBER OF WEED SEEDS TO THE POUND IN SIXTY-ONE SAMPLES OF LOW-GRADE RED CLOVER SEED IMPORTED DURING THE YEAR ENDED JUNE 30, 1906.

Sample No. 2945.—Black-seeded plantain, 95,580; lady's-thumb, 1,530; knotweed, 90; spurge, 1,440; mayweed, 450; catmint, 180; green foxtail, 4,320; yellow foxtail, 450; buckhorn, 1,890; bracted plantain, 540; chickweed, 270; curled dock, 1,260; bitter dock, 540; sorrel, 810; healall, 540; peppergrass, 360; wild carrot, 360; small crab-grass, 6,480; crab-grass, 5,670; slender paspalum, 1,350; pennyroyal, 2,700; stink-grass, 90; yellow trefoil, 540; five-finger, 180; barnyard grass, 90; spiny sida, 90; sedge, 90; three-seeded mercury, 270; vervain, 720; tumbling amaranth, 1,620; rough pigweed, 900; lamb's-quarters, 1,080; witch-grass, 7,470; spreading panicum, 990; prickly lettuce, 90; other weed seeds, 3,420.

Total weed seeds to the pound, 144,450.

Sample No. 2946.—Buckhorn, 16,200; clover dodder, 38,160; wild carrot, 5,256; healall, 4,608; low hop-clover, 648; plantain, 72; sorrel, 2,808; yellow trefoil, 144; wild chicory, 432; vervain, 432; field camomile, 360; mayweed, 72; woodrush, 72; mouse-ear chickweed, 72; lamb's-quarters, 72; hawkweed picris, 72; round-leaved toad-flax, 72; small-flowered crane's-bill, 216; bird's-foot trefoil, 72; other weed seeds, 1,728.

Total weed seeds to the pound, 71,568.

Sample No. 2947.—Buckhorn, 13,860; black-seeded plantain, 3,150; bracted plantain, 90; plantain, 90; yellow trefoil, 540; clover dodder, 3,600; Chilean clover dodder, 540; wild carrot, 3,060; sorrel, 1,350; curled dock, 270; vervain, 1,080; white vervain, 180; green foxtail, 810; lamb's-quarters, 810; healall, 630; bird's-foot trefoil, 360; hop-clover, 360; low hop-clover, 90; wild chicory, 270; kidney vetch, 90; witch-grass, 180; knotweed, 180; lady's-thumb, 90; small crab-grass, 90; ox-tongue, 90; spurry, 90; alfilaria, 90; other weed seeds, 810.

Total weed seeds to the pound, 32,850.

Sample No. 3101.—Green foxtail, 96,135; witch-grass, 1,020; plantain, 595; lamb's-quarters, 425; yellow trefoil, 595; small crab-grass, 255; lady's-thumb, 170; three-seeded mercury, 85; ragweed, 85; other weed seeds, 340.

Total weed seeds to the pound, 99,705.

Sample No. 3159.—Buckhorn, 24,130; Chilean clover dodder, 14,250; sorrel, 3,910; wild carrot, 3,910; healall, 3,825; yellow trefoil, 850; bird's-foot trefoil, 425; lamb's-quarters, 340; wild chicory, 340; ox-tongue, 340; green foxtail, 170; mayweed, 170; field camomile, 170; hop-clover, 170; mouse-ear chickweed, 85; small crab-grass, 85; low hop-clover, 170; chickweed, 85; kidney vetch, 85; red pimpernel, 85; small-flowered crane's-bill, 85; saltbush, 85; other weed seeds, 595.

Total weed seeds to the pound, 54,360.

Sample No. 3222.—Buckhorn, 93,678; clover dodder, 15,132; healall, 6,084; wild carrot, 3,276; sorrel, 2,652; yellow trefoil, 1,716; black-seeded plantain, 546; lamb's-quarters, 390; curled dock, 390; spurry, 390; bird's-foot trefoil, 312; vervain, 312; hop-clover, 234; saltbush, 156; lesser starwort, 156; mayweed, 156; white vervain, 78; chickweed, 78; ox-eye daisy, 78; green foxtail, 78; blue field madder, 78; peppergrass, 78; other weed seeds, 468.

Total weed seeds to the pound, 126,516.

Sample No. 3395.—Buckhorn, 13,940; clover dodder, 25,415; healall, 9,180; wild carrot, 5,015; sorrel, 5,490; yellow trefoil, 1,360; lamb's-quarters, 765; black-seeded plantain, 765; spurry, 425; hop-clover, 340; vervain, 255; curled dock, 255; rabbit's-foot clover, 170; wild chicory, 170; mayweed, 170; red pimpernel, 85; bird's-foot trefoil, 85; green foxtail, 85; other weed seeds, 595.

Total weed seeds to the pound, 64,565.

Sample No. 3400.—Buckhorn, 5,780; clover dodder, 8,364; sorrel, 7,790; healall, 4,592; yellow trefoil, 1,886; wild carrot, 1,558; lamb's-quarters, 656; field dodder, 410; red pimpernel, 328; hop-clover, 328; lesser starwort, 164; woodrush, 164; low hop-clover, 164; rabbit's-foot clover, 82; chickweed, 82; bitter dock, 82; small-seeded false flax, 82; vervain, 82; other weed seeds, 3,526.

Total weed seeds to the pound, 36,120.

Sample No. 3425.—Catchfly, 14,790; green foxtail, 5,780; sorrel, 4,674; buckhorn, 3,444; yellow trefoil, 3,198; curled dock, 3,280; plantain, 2,214; black-seeded plantain, 1,066; lamb's-quarters, 1,066; mayweed, 820; Canada thistle, 820; small crab-grass, 738; witch-grass, 410; mouse-ear chickweed, 410; lady's-thumb, 246; healall, 246; catmint, 164; evening primrose, 164; five-finger, 164; field cress, 164; stick-tight, 164; ragweed, 82; yellow foxtail, 164; chickweed, 82; other weed seeds, 492.

Total weed seeds to the pound, 44,842.

Sample No. 3432.—Buckhorn, 21,074; black-seeded plantain, 10,168; clover dodder, 11,316; wild carrot, 5,002; healall, 1,558; sorrel, 1,230; lamb's-quarters, 820; witch-grass, 656; yellow trefoil, 574; spreading panicum, 328; crab-grass, 410; small crab-grass, 492; chicory, 410; low hop-clover, 328; curled dock, 246; ragweed, 246; spurge, 164; mouse-ear chickweed, 164; bracted plantain, 82; forget-me-not, 82; catmint, 82; plantain, 82; barnyard grass, 82; five-finger, 82; small-seeded false flax, 82; Canada thistle, 82; red pimpernel, 246; hawkweed picris, 82; chickweed, 82; lesser starwort, 82; peppergrass, 82; bird's-foot trefoil, 82; scentless camomile, 82; other weed seeds, 1,558.

Total weed seeds to the pound, 58,138.

Sample No. 3456.—Buckhorn, 36,982; wild carrot, 36,326; yellow trefoil, 2,050; wild chicory, 4,264; clover dodder, 4,592; field dodder, 656; vervain, 2,542; healall, 1,968; low hop-clover, 82; sorrel, 984; curled dock, 410; hawkweed picris, 820; ox-tongue, 656; field camomile, 656; lamb's-quarters, 574; red pimpernel, 492; green foxtail, 410; black-seeded plantain, 164; lesser starwort, 164; Canada thistle, 82; nipplewort, 82; cat's-ear, 82; knotweed, 82; barnyard grass, 82; small crab-grass, 82; other weed seeds, 2,296.

Total weed seeds to the pound, 97,580.

Sample No. 3457.—Buckhorn, 35,700; wild carrot, 32,725; chicory, 4,845; clover dodder, 4,760; healall, 3,230; yellow trefoil, 1,785; sorrel, 1,105; lamb's-quarters, 850; green foxtail, 425; red pimpernel, 425; dodder, 425; field camomile, 340; ox-tongue, 340; curled dock, 340; hawkweed picris, 255; knotweed, 255; cut-leaved crane's-bill, 170; nipplewort, 170; black-seeded plantain, 170; mayweed, 85; lesser starwort, 85; bracted plantain, 85; spiny sow thistle, 85; other weed seeds, 5,015.

Total weed seeds to the pound, 93,070.

Sample No. 3488.—Buckhorn, 6,314; sorrel, 3,936; green foxtail, 3,198; curled dock, 2,050; lamb's-quarters, 1,640; black-seeded plantain, 1,476; plantain, 984; bitter dock, 820; catmint, 1,148; lesser starwort, 656; Canada thistle, 656; mouse-ear

chickweed, 574; mayweed, 902; lady's-thumb, 410; yellow trefoil, 328; small crab-grass, 246; stick-tight, 328; three-seeded mercury, 164; barnyard grass, 246; yellow foxtail, 164; knotweed, 82; healall, 82; witch-grass, 82; other weed seeds, 1,804.

Total weed seeds to the pound, 28,290.

Sample No. 3566.—Buckhorn, 19,890; clover dodder, 13,050; sorrel, 8,460; healall, 3,600; wild carrot, 3,420; yellow trefoil, 1,530; rabbit's-foot clover, 1,260; green foxtail, 990; low hop-clover, 630; black-seeded plantain, 450; spurry, 270; wild chicory, 270; hop-clover, 180; chickweed, 180; lesser starwort, 90; blue field madder, 90; Canada thistle, 90; small crab-grass, 90; mayweed, 90; field camomile, 90; other weed seeds, 6,300.

Total weed seeds to the pound, 61,020.

Sample No. 3571.—Green foxtail, 5,100; black-seeded plantain, 7,225; buckhorn, 3,910; plantain, 1,955; lamb's-quarters, 3,145; curled dock, 1,275; sorrel, 1,615; yellow trefoil, 2,805; witch-grass, 1,785; barnyard grass, 170; mayweed, 850; small crab-grass, 510; Canada thistle, 255; lady's-thumb, 170; mouse-ear chickweed, 170; small-seeded false flax, 85; catmint, 85; healall, 85; other weed seeds, 1,700.

Total weed seeds to the pound, 32,895.

Sample No. 3587.—Buckhorn, 23,322; wild carrot, 11,856; clover dodder, 14,742; healall, 3,042; sorrel, 2,028; lamb's-quarters, 1,560; yellow trefoil, 1,482; wild chicory, 1,248; plantain, 546; green foxtail, 468; rabbit's-foot clover, 390; low hop-clover, 312; curled dock, 312; mayweed, 234; red pimpernel, 234; evening primrose, 156; scentless camomile, 156; dove's-foot crane's-bill, 156; saltbush, 156; vervain, 3,198; small crab-grass, 156; five-finger, 156; field camomile, 156; lady's-thumb, 78; black-seeded plantain, 78; stick-tight, 78; kidney vetch, 78; frenchweed, 78; spurry, 78; ox-tongue, 78; witch-grass, 78; other weed seeds, 4,134.

Total weed seeds to the pound, 70,824.

Sample No. 3588.—Buckhorn, 24,055; dodder, 6,205; sorrel, 6,120; black-seeded plantain, 4,505; wild carrot, 2,720; healall, 2,805; lamb's-quarters, 1,615; yellow trefoil, 1,275; field camomile, 340; spurge, 510; small crab-grass, 595; low hop-clover, 425; green foxtail, 425; wild chicory, 340; bird's-foot trefoil, 340; crab-grass, 170; bracted plantain, 170; mayweed, 255; lady's-thumb, 170; lesser starwort, 85; yellow foxtail, 85; witch-grass, 85; five-finger, 85; spurry, 85; rabbit's-foot clover, 85; large-seeded false flax, 85; other weed seeds, 3,400.

Total weed seeds to the pound, 57,035.

Sample No. 3591.—Sorrel, 15,215; wild carrot, 10,710; lamb's-quarters, 9,945; buckhorn, 7,905; yellow trefoil, 4,565; healall, 2,975; catchfly, 2,295; curled dock, 2,040; black-seeded plantain, 1,785; green foxtail, 1,615; dodder, 850; kidney vetch, 510; saltbush, 425; red pimpernel, 340; small crab-grass, 340; slender paspalum, 255; wild chicory, 255; mayweed, 255; field camomile, 170; chickweed, 170; frenchweed, 170; spurry, 85; catmint, 85; lady's-thumb, 85; small-flowered crane's-bill, 85; other weed seeds, 1,020.

Total weed seeds to the pound, 64,150.

Sample No. 3598.—Sorrel, 56,706; buckhorn, 14,820; clover dodder, 18,876; wild carrot, 5,070; yellow trefoil, 2,106; healall, 1,326; lamb's-quarters, 624; green foxtail, 546; plantain, 468; wild chicory, 468; small crab-grass, 234; scentless camomile, 234; forget-me-not, 234; lesser starwort, 156; mouse-ear chickweed, 156; low hop-clover, 156; knotweed, 156; ox-eye daisy, 156; rabbit's-foot clover, 78; bird's-foot trefoil, 78; woodrush, 156; red pimpernel, 78; blue field madder, 78; cut-leaved crane's-bill, 78; saltbush, 78; field camomile, 312; other weed seeds, 1,092.

Total weed seeds to the pound, 104,520.

Sample No. 3647.—Buckhorn, 11,872; clover dodder, 25,424; sorrel, 6,608; healall, 4,592; wild carrot, 4,144; yellow trefoil, 2,352; lamb's-quarters, 784; vervain, 560; low hop-clover, 448; green foxtail, 336; small crab-grass, 336; lesser starwort, 336; red pimpernel, 336; chickweed, 224; spurry, 224; curled dock, 112; lady's-thumb, 112;

hop-clover, 112; mayweed, 112; field camomile, 112; small-seeded false flax, 112; other weed seeds, 3,584.

Total weed seeds to the pound, 62,832.

Sample No. 3696.—Yellow trefoil, 2,542; clover dodder, 29,520; buckhorn, 12,218; wild carrot, 8,528; low hop-clover, 984; hop-clover, 410; healall, 5,330; sorrel, 7,626; curled dock, 164; lamb's-quarters, 2,132; vervain, 1,066; red pimpernel, 574; lesser starwort, 574; green foxtail, 574; mayweed, 246; field camomile, 246; wild chicory, 164; kidney vetch, 164; bird's-foot trefoil, 164; spurry, 164; barnyard grass, 82; small crab-grass, 82; blue field madder, 82; wood rush, 82; other weed seeds, 3,444.

Total weed seeds to the pound, 77,162.

Sample No. 3721.—Buckhorn, 7,735; green foxtail, 4,250; sorrel, 2,380; curled dock, 2,210; lamb's-quarters, 1,615; plantain, 1,445; bitter dock, 1,275; black-seeded plantain, 850; yellow trefoil, 765; catmint, 595; Canada thistle, 425; lady's-thumb, 340; mouse-ear chickweed, 255; small crab-grass, 255; knotweed, 170; mayweed, 170; other weed seeds, 2,125.

Total weed seeds to the pound, 26,860.

Sample No. 3755.—Green foxtail, 3,740; buckhorn, 3,400; black-seeded plantain, 2,720; sorrel, 2,720; lamb's-quarters, 2,125; catmint, 1,700; curled dock, 1,615; Canada thistle, 1,190; black-seeded plantain, 1,275; yellow trefoil, 595; lady's-thumb, 510; witch-grass, 340; barnyard grass, 340; lesser starwort, 255; mouse-ear chickweed, 255; mayweed, 255; small crab-grass, 255; ragweed, 255; stick-tight, 170; ox-eye daisy, 170; chickweed, 85; wild chicory, 85; yellow foxtail, 85; three-seeded mercury, 85; small-seeded false flax, 85; other weed seeds, 2,890.

Total weed seeds to the pound, 27,200.

Sample No. 3810.—Buckhorn, 7,020; dodder, 6,930; lamb's-quarters, 4,950; green foxtail, 3,420; healall, 2,790; sorrel, 3,060; wild carrot, 2,430; yellow trefoil, 810; saltbush, 1,080; red pimpernel, 900; mayweed, 270; field camomile, 180; vervain, 90; wild chicory, 90; low hop-clover, 90; rabbit's-foot clover, 90; hop-clover, 90; bird's-foot trefoil, 90; lesser starwort, 90; sweet clover, 90; other weed seeds, 1,980.

Total weed seeds to the pound, 36,540.

Sample No. 3811.—Clover dodder, 18,700; buckhorn, 19,380; lamb's-quarters, 5,355; green foxtail, 4,080; sorrel, 3,315; wild carrot, 3,060; healall, 2,550; yellow trefoil, 1,360; saltbush, 1,190; wild chicory, 680; red pimpernel, 425; rabbit's-foot clover, 340; white campion, 170; ox-tongue, 170; hawkweed picris, 85; early winter cress, 170; Canada thistle, 85; mayweed, 85; field camomile, 85; bitter dock, 85; curled dock, 85; lady's-thumb, 85; knotweed, 85; kidney vetch, 85; chickweed, 85; sweet clover, 85; black-seeded plantain, 85; mallow, 85; spurry, 85; stick-tight, 85; blue field madder, 85; other weed seeds, 2,635.

Total weed seeds to the pound, 64,940.

Sample No. 3816.—Buckhorn, 13,104; clover dodder, 6,240; wild carrot, 5,304; sorrel, 4,914; healall, 4,758; yellow trefoil, 2,574; lamb's-quarters, 1,170; green foxtail, 546; kidney vetch, 468; low hop-clover, 312; round-leaf toad flax, 234; curled dock, 234; lesser starwort, 234; chickweed, 78; ox-tongue, 156; black-seeded plantain, 156; plantain, 78; forget-me-not, 78; wood rush, 78; small crab-grass, 78; bull thistle, 78; bird's-foot trefoil, 78; other weed seeds, 3,900.

Total weed seeds to the pound, 44,850.

Sample No. 3834.—Clover dodder, 7,055; field dodder, 680; buckhorn, 7,820; sorrel, 6,205; healall, 4,420; wild carrot, 2,975; lamb's-quarters, 2,125; yellow trefoil, 1,190; green foxtail, 425; curled dock, 255; rabbit's-foot clover, 170; bird's-foot trefoil, 170; small-flowered crane's-bill, 170; chickweed, 170; yellow foxtail, 85; black-seeded plantain, 85; ox-tongue, 85; forget-me-not, 85; other weed seeds, 3,145.

Total weed seeds to the pound, 37,315.

Sample No. 3906.—Buckhorn, 14,305; clover dodder, 28,475; sorrel, 6,375; wild carrot, 6,375; healall, 6,375; lamb's-quarters, 3,145; yellow trefoil, 3,060; green fox-

tail, 2,295; black-seeded plantain, 1,275; low hop-clover, 935; rabbit's-foot clover, 850; red pimpernel, 680; curled dock, 680; mayweed, 425; bird's-foot trefoil, 340; kidney vetch, 340; hop-clover, 255; witch-grass, 170; ox-tongue, 170; lesser starwort, 170; round-leaved toad flax, 170; small-flowered crane's-bill, 85; ragweed, 85; spurry, 85; small crab-grass, 85; lady's-thumb, 85; sweet clover, 85; nipplewort, 85; other weed seeds, 4,845.

Total weed seeds to the pound, 82,305.

Sample No. 3945.—Buckhorn, 22,050; clover dodder, 6,570; healall, 3,960; green foxtail, 2,430; wild carrot, 2,430; lamb's-quarters, 2,340; yellow trefoil, 1,980; sorrel, 1,350; bird's-foot trefoil, 540; red pimpernel, 540; ox-tongue, 90; vervain, 270; small crab-grass, 180; low hop-clover, 90; lady's-thumb, 90; slender paspalum, 90; curled dock, 90; wild chicory, 90; field camomile, 90; hawkweed picris, 90; mayweed, 90; hop-clover, 90; other weed seeds, 2,430.

Total weed seeds to the pound, 47,970.

Sample No. 3946.—Buckhorn, 14,400; yellow trefoil, 3,570; healall, 1,615; clover dodder, 1,445; kidney vetch, 935; green foxtail, 850; lamb's-quarters, 1,020; sorrel, 850; wild carrot, 255; rabbit's-foot clover, 170; bird's-foot trefoil, 170; round-leaved toad flax, 85; ox-tongue, 85; bur clover, 85; small-flowered crane's-bill, 85; other weed seeds, 1,020.

Total weed seeds to the pound, 26,640.

Sample No. 3959.—Sorrel, 680; lamb's-quarters, 425; sweet clover, 425; green foxtail, 85; wild carrot, 85; yellow trefoil, 85; dodder, 85; lesser starwort, 85; rabbit's-foot clover, 85; other weed seeds, 595.

Total weed seeds to the pound, 2,635.

Sample No. 3960.—Buckhorn, 1,700; lamb's-quarters, 1,190; clover dodder, 850; yellow trefoil, 595; low hop-clover, 510; wild carrot, 340; green foxtail, 340; yellow foxtail, 255; blueweed, 170; rabbit's-foot clover, 170; sorrel, 170; healall, 85; sweet clover, 85; field camomile, 85; scentless camomile, 85; small-seeded false flax, 85; other weed seeds, 425.

Total weed seeds to the pound, 7,140.

Sample No. 3962.—Dodder, 1,190; buckhorn, 425; lamb's-quarters, 255; sweet clover, 510; low hop-clover, 85; curled dock, 85; yellow trefoil, 85; blueweed, 85; kidney vetch, 85; other weed seeds, 510.

Total weed seeds to the pound, 3,315.

Sample No. 3963.—Buckhorn, 2,028; wild carrot, 546; sorrel, 390; clover dodder, 936; field camomile, 156; yellow foxtail, 78; wild chicory, 78; healall, 78; lamb's-quarters, 390; other weed seeds, 702.

Total weed seeds to the pound, 5,382.

Sample No. 3964.—Buckhorn, 3,690; sorrel, 1,722; clover dodder, 1,066; lamb's-quarters, 246; lesser starwort, 82; yellow foxtail, 82; healall, 82; forget-me-not, 82; other weed seeds, 574.

Total weed seeds to the pound, 7,626.

Sample No. 3965.—Low hop-clover, 170; lamb's-quarters, 170; buckhorn, 85; healall, 85; wild carrot, 85; forget-me-not, 85; blueweed, 85; dodder, 85; chickweed, 85.

Total weed seeds to the pound, 935.

Sample No. 3967.—Lamb's-quarters, 1,615; buckhorn, 1,020; dodder, 850; yellow trefoil, 340; wild carrot, 255; sweet clover, 170; rabbit's-foot clover, 170; forget-me-not, 85; red pimpernel, 85; field camomile, 85; sorrel, 85; other weed seeds, 850.

Total weed seeds to the pound, 5,610.

Sample No. 3990.—Green foxtail, 20,060; curled dock, 4,590; bitter dock, 170; lamb's-quarters, 5,440; buckhorn, 680; yellow trefoil, 850; lady's-thumb, 425; stick-tight, 255; sorrel, 170; mayweed, 170; Canada thistle, 170; ragweed, 170; barnyard grass, 85; other weed seeds, 850.

Total weed seeds to the pound, 34,085.

Sample No. 3994.—Plantain, 26,814; mouse-ear chickweed, 12,300; five-finger, 3,608; buckhorn, 2,788; lamb's-quarters, 3,115; sorrel, 2,378; curled dock, 2,132; shepherd's-purse, 1,804; black-seeded plantain, 1,722; mayweed, 1,722; small crab-grass, 738; yellow trefoil, 656; lady's-thumb, 492; stick-tight, 410; witch-grass, 410; wormseed mustard, 328; peppergrass, 328; barnyard grass, 246; yellow foxtail, 82; evening primrose, 82; spiny sow thistle, 82; sedge, 82; catmint, 82; clover dodder, 82; knotweed, 82; three-seeded mercury, 82; green foxtail, 5,740; Canada thistle, 904; small-seeded false flax, 82; clover dodder, 82; other weed seeds, 4,018.

Total weed seeds to the pound, 73,473.

Sample No. 4009.—Buckhorn, 12,948; wild chicory, 1,968; yellow trefoil, 2,460; wild carrot, 1,640; hop-clover, 82; rabbit's-foot clover, 82; clover dodder, 820; Chilean clover dodder, 164; green foxtail, 984; yellow foxtail, 246; healall, 820; saltbush, 738; lamb's-quarters, 656; kidney vetch, 492; black-seeded plantain, 82; bracted plantain, 82; plantain, 82; barnyard grass, 328; sorrel, 410; curled dock, 328; knotweed, 246; field camomile, 246; mayweed, 82; sweet clover, 164; ragweed, 164; red pimpernel, 164; Canada thistle, 82; cut-leaved crane's-bill, 82; bird's-foot trefoil, 82; nipplewort, 82; sticktight, 82; other weed seeds, 2,788.

Total weed seeds to the pound, 29,676.

Sample No. 4010.—Buckhorn, 23,375; sorrel, 11,730; clover dodder, 11,815; healall, 6,460; yellow trefoil, 4,675; lamb's-quarters, 2,465; wild carrot, 1,105; red pimpernel, 1,190; low hop-clover, 1,105; rabbit's-foot clover, 1,105; mouse-ear chickweed, 1,360; lesser starwort, 935; hop-clover, 935; vervain, 850; chickweed, 255; spurry, 255; kidney vetch, 255; green foxtail, 255; mayweed, 170; field camomile, 85; forget-me-not, 85; small-flowered crane's-bill, 85; bur clover, 85; black-seeded plantain, 85; plantain, 85; other weed seeds, 8,330.

Total weed seeds to the pound, 79,135.

Sample No. 4026.—Buckhorn, 60,210; green foxtail, 6,390; ox-tongue, 6,930; wild carrot, 5,950; clover dodder, 3,570; yellow trefoil, 3,315; red pimpernel, 2,040; healall, 1,955; bird's-foot trefoil, 1,785; ox-tongue, 1,445; round-leaved toad flax, 1,190; wild chicory, 340; hawkweed picris, 255; mayweed, 85; other weed seeds, 1,275.

Total weed seeds to the pound 96,735.

Sample No. 4029.—Yellow trefoil, 5,220; buckhorn, 1,615; sorrel, 1,360; lamb's-quarters, 595; healall, 85; yellow foxtail, 85; other weed seeds, 510.

Total weed seeds to the pound, 9,470.

Sample No. 4031.—Clover dodder, 11,730; sorrel, 765; lamb's-quarters, 680; wild carrot, 595; healall, 510; black-seeded plantain, 255; buckhorn, 255; curled dock, 85; five-finger, 85; other weed seeds, 170.

Total weed seeds to the pound, 15,130.

Sample No. 4032.—Lamb's-quarters, 20,418; lady's-thumb, 410; cleavers, 656; curled dock, 410; saltbush, 246; stick-tight, 246; small-seeded false flax, 164; yellow trefoil, 164; sorrel, 82; other weed seeds, 574.

Total weed seeds to the pound, 23,370.

Sample No. 4035.—Lamb's-quarters, 5,304; buckhorn, 936; clover dodder, 780; sorrel, 546; rabbit's-foot clover, 156; yellow trefoil, 234; wild carrot, 156; blueweed, 156; green foxtail, 78; spurry, 78; bird's-foot trefoil, 78; other weed seeds, 3,822.

Total weed seeds to the pound, 12,324.

Sample No. 4038.—Clover dodder, 1,170; lamb's-quarters, 2,880; wild carrot, 360; scentless camomile, 270; wild chicory, 180; mayweed, 90; healall, 90; red pimpernel, 90; plantain, 90; sorrel, 90; hop-clover, 90; other weed seeds, 540.

Total weed seeds to the pound, 5,940.

Sample No. 4044.—Buckhorn, 12,710; clover dodder, 18,204; wild carrot, 6,630; sorrel, 2,865; healall, 3,910; yellow trefoil, 3,230; lamb's-quarters, 2,465; green foxtail, 1,615; curled dock, 1,530; round-leaved toad flax, 1,105; red pimpernel, 1,020; black-seeded plantain, 680; hop-clover, 595; low hop-clover, 510; spurry, 340; lesser star-

wort, 340; mayweed, 255; field camomile, 170; small crab-grass, 170; kidney vetch, 255; yellow foxtail, 85, stick-tight, 85; wild chicory, 85; lady's-thumb, 85; ox-tongue, 85; chickweed, 85; other weed seeds, 5,100.

Total weed seeds to the pound, 64,209.

Sample No. 4051.—Sorrel, 2,720; lamb's-quarters, 340; rabbit's-foot clover, 340; black-seeded plantain, 255; knotweed, 85.

Total weed seeds to the pound, 3,740.

Sample No. 4053.—Low hop-clover, 85; buckhorn, 170; field camomile, 170; clover dodder, 85; healall, 85; other weed seeds, 425.

Total weed seeds to the pound, 1,020.

Sample No. 4067.—Buckhorn, 15,030; green foxtail, 8,100; black-seeded plantain, 7,650; barnyard grass, 630; yellow foxtail, 540; three-seeded mercury, 540; knotweed, 270; lady's-thumb, 270; plantain, 270; five-finger, 180; yellow trefoil, 90; lamb's-quarters, 90; curled dock, 90; witch-grass, 90; other weed seeds, 360.

Total weed seeds to the pound, 34,200.

Sample No. 4084.—Lady's-thumb, 10,030; plantain, 20,740; mouse-ear chickweed, 17,000; curled dock, 3,230; shepherd's-purse, 2,975; yellow trefoil, 1,785; lamb's-quarters, 1,700; five-finger, 1,615; green foxtail, 935; black-seeded plantain, 850; Canada thistle, 680; spiny sow thistle, 255; yellow foxtail, 170; knotweed, 85; other weed seeds, 340.

Total weed seeds to the pound, 62,390.

Sample No. 4097.—Buckhorn, 16,405; clover dodder, 24,820; wild carrot, 6,290; sorrel, 6,205; healall, 6,035; yellow trefoil, 3,910; green foxtail, 3,485; lamb's-quarters, 3,400; kidney vetch, 1,020; vervain, 935; red pimpernel, 850; black-seeded plantain, 595; low hop-clover, 510; mayweed, 510; curled dock, 510; rabbit's-foot clover, 425; lesser starwort, 240; ox-tongue, 255; saltbush, 255; field camomile, 170; wild chicory, 170; lady's-thumb, 170; small crab-grass, 170; blue field madder, 85; slender paspalum 85; ragweed, 85; small-flowered crane's-bill, 85; hedge mustard, 85; hop-clover, 85; sweet clover, 85; other weed seeds, 7,395.

Total weed seeds to the pound, 85,325.

Sample No. 4118.—Yellow trefoil, 20,790; buckhorn, 20,610; healall, 3,510; wild carrot, 3,150; clover dodder, 2,970; sorrel, 2,160; catchfly, 1,080; lamb's-quarters, 990; field camomile, 900; red pimpernel, 540; kidney vetch, 270; green foxtail, 180; scentless camomile, 180; chickweed, 180; small-flowered crane's-bill, 180; Canada thistle, 90; wild chicory, 90; lady's-thumb, 90; lesser starwort, 90; cut-leaved crane's-bill, 90; blue field madder, 90; field dodder, 90; other weed seeds, 1,980.

Total weed seeds to the pound, 60,300.

Sample No. 4163.—Buckhorn, 4,410; plantain, 3,825; green foxtail, 3,655; mayweed, 1,870; black-seeded plantain, 1,530; curled dock, 765; five-finger, 425; catmint, 340; sorrel, 340; lady's-thumb, 340; Canada thistle, 340; ragweed, 255; mouse-ear chickweed, 170; barnyard grass, 170; yellow trefoil, 170; wild basil, 170; yellow foxtail, 85; wormseed mustard, 85; small crab-grass, 85; other weed seeds, 2,635.

Total weed seeds to the pound, 21,665.

Sample No. 4165.—Black-seeded plantain, 93,585; green foxtail, 6,035; small crab-grass, 7,055; crab-grass, 4,760; witch-grass, 4,845; buckhorn, 2,720; curled dock, 2,380; lady's-thumb, 1,785; pennyroyal, 1,445; lamb's-quarters, 1,360; bracted plantain, 1,445; spurge, 1,275; yellow foxtail, 1,105; spreading panicum, 595; sorrel, 850; pepper-grass, 340; evening primrose, 255; mayweed, 255; yellow trefoil, 255; slender paspalum, 170; barnyard grass, 170; spiny sida, 170; wild carrot, 170; catmint, 85; three-seeded mercury, 85; other weed seeds, 4,080.

Total weed seeds to the pound, 137,275.

Sample No. 4179.—Buckhorn, 20,202; clover dodder, 35,802; wild carrot, 5,772; lamb's-quarters, 5,070; sorrel, 5,070; yellow trefoil, 2,886; healall, 3,822; low hop-clover, 1,092; green foxtail, 1,014; red pimpernel, 624; dodder, 468; vervain, 546;

rabbit's-foot clover, 468; oxtongue, 390; hop-clover, 312; curled dock, 234; saltbush, 234; field camomile, 234; mayweed, 156; wild chicory, 156; black-seeded plantain, 156; nettle-leaved goosefoot, 78; forget-me-not, 78; mouse-ear chickweed, 78; lady's-thumb, 78; scentless camomile, 312; plantain, 78; chickweed, 78; lesser starwort, 234; kidney vetch, 78; other weed seeds, 3,822.

Total weed seeds to the pound, 91,422.

Sample No. 4180.—Buckhorn, 27,716; clover dodder, 35,670; low hop-clover, 1,445; rabbit's-foot clover, 255; wild carrot, 3,400; sorrel, 3,485; yellow trefoil, 3,145; healall, 2,890; lamb's-quarters, 2,720; field camomile, 765; red pimpernel, 595; green foxtail, 510; wild chicory, 425; lesser starwort, 340; chickweed, 85; nipplewort, 85; Canada thistle, 85; forget-me-not, 85; small-flowered crane's-bill, 85; bird's-foot trefoil, 85; small-seeded false flax, 85; other weed seeds, 3,145.

Total weed seeds to the pound, 77,101.

Sample No. 4181.—Buckhorn, 21,690; clover dodder, 46,980; sorrel, 7,565; wild carrot, 5,780; lamb's-quarters, 4,760; healall, 4,335; yellow trefoil, 2,465; green foxtail, 1,360; lesser starwort, 935; red pimpernel, 850; scentless camomile, 765; low hop-clover, 765; round-leaved toad flax, 595; rabbit's-foot clover, 510; black-seeded plantain, 595; field camomile, 340; kidney vetch, 340; wild chicory, 340; spurry, 255; chickweed, 170; ox-tongue, 170; forget-me-not, 170; saltbush, 170; hop-clover, 170; ox-eye daisy, 170; yarrow, 85; plantain, 85; mayweed, 85; curled dock, 85; other weed seeds, 5,440.

Total weed seeds to the pound, 90,025.

Sample No. 4183.—Buckhorn, 9,540; clover dodder, 8,460; lamb's-quarters, 6,210; green foxtail, 4,320; oxtongue, 1,710; round-leaved toad flax, 1,800; yellow trefoil, 1,260; red pimpernel, 900; low hop-clover, 810; wild carrot, 540; sorrel, 360; hawkweed picris, 360; healall, 180; large-seeded false flax, 180; mayweed, 180; forget-me-not, 180; rabbit's-foot clover, 90; spurry, 90; witch grass, 90; field camomile, 90; small-seeded false flax, 90; field cress, 90; horehound, 90; Frenchweed, 90; bull thistle, 90; other weed seeds, 3,510.

Total weed seeds to the pound, 41,310.

Sample No. 4225.—Buckhorn, 26,910; Chilean dodder, 5,940; wild carrot, 9,360; sorrel, 7,560; catchfly, 7,380; healall, 6,390; clover dodder, 6,210; lamb's-quarters, 3,600; yellow trefoil, 2,610; small-flowered crane's-bill, 900; lesser starwort, 810; red pimpernel, 630; green foxtail, 630; spurry, 540; mayweed, 540; small crab-grass, 450; kidney vetch, 360; bird's-foot trefoil, 270; plantain, 270; blue field madder, 180; forget-me-not, 180; yellow foxtail, 180; oxeye daisy, 90; scentless camomile, 90; curled dock, 90; spurge, 90; slender paspalum, 90; chickweed, 90; hop clover, 90; low hop-clover, 90; other weed seeds, 5,760.

Total weed seeds to the pound, 88,380.

In Table II are given the analyses of the five samples of high-grade red clover offered for sale at an average price of $15.05 per hundred pounds, previously referred to.

TABLE II.—*Analyses of five samples of high-grade red clover seed offered for sale during the year ended June 30, 1906.*

Number of seed sample.	Red clover seed.	Other seeds.	Dirt and broken seed.	Dodder present.	Kinds of weed seeds.	Weight of 1,000 red clover seeds.	Germination of red clover seed.	Price per 100 pounds at which seed was offered for sale.	Live red clover seed (seed that germinated) in sample.	Actual cost of 100 pounds of red clover seed that germinated.
	Per cent.	*Per cent.*	*Per cent.*		*Number.*	*Milligrams.*	*Per cent.*		*Per cent.*	
36668	96.59	1.44	1.97	No.	7	1,705	100	$15.00	96.59	$15.53
37427	98.54	.28	1.18	No.	2	1,501	98.5	14.00	97.06	14.42
37440	98.42	.93	.65	No.	7	1,531	97.5	14.75	95.96	15.37
37442	97.00	1.27	1.73	No.	7	1,678	100	16.00	97.00	16.49
37443	98.10	.35	1.55	No.	3	1,486	98	15.50	96.14	16.12
Average.	97.73	.85	1.42		5.2	1,580	98.8	15.05	96.55	15.58

The accompanying diagram presents in graphic form a comparison of the averages of the analyses of red clover seed imported, as shown in Tables I and II.

ALFALFA.

Table III gives the analyses of sixteen selected low-grade samples of imported alfalfa seed, representing cargoes amounting to 275,572 pounds. Since the total importations of alfalfa seed during the same period were 5,688,689 pounds, the low-grade seed furnished about one-twentieth of the total. The quality of this low-grade seed is similar to that of the red clover seed shown in Table I. The germination is low and the seed in many samples is small or shriveled. All but two of these lots contain dodder, and all contained on an average more than fifteen kinds of weed seeds.

TABLE III.—*Analyses of sixteen samples of low-grade alfalfa seed imported during the fiscal year ended June 30, 1906.*

Number of seed sample.	Alfalfa seed.	Other seeds.	Dirt and broken seed.	Dodder present.[a]	Kinds of weed seeds.	Weight of 1,000 alfalfa seeds.	Germination of alfalfa seed.	Quantity of seed imported.[b]	Price per 100 pounds at which seed was imported.	Live alfalfa seed (seed that germinated) in sample.	Actual cost of 100 pounds of alfalfa seed that germinated.
	Per cent.	*Per cent.*	*Per cent.*		*Number.*	*Milligrams.*	*Per cent.*	*Pounds*		*Per cent.*	
2929	84.56	3.52	11.92	Yes.	18	1,704	79.5	10,208	$9.50	67.22	$14.13
2941	96.18	1.28	2.54	No.	1	2,166	46	12,106	8.10	44.24	18.30
2942	88.58	1.98	9.44	Yes.	14	1,890	53	7,797	7.90	46.95	16.83
2996	89.42	3.68	6.9	No.	10	1,787	56.5	16,475	9.25	50.52	18.31
3002	88.06	3.24	8.7	No.	12	1,866	52.5	32,439	9.40	46.23	20.33
3003	87.8	3.54	8.66	No.	12	1,748	45	15,923	9.90	39.5	25.06
3047	90.46	3.97	5.57	Yes.	14	1,757	58	16,610	10.25	52.47	19.53
3068	94.38	2.59	3.03	Yes.	9	1,834	50	14,475	8.50	47.19	18.01
3082	91.01	4.33	4.66	Yes.	15	1,622	63.5	16,632	10.25	57.79	17.73
3158	90.8	4.68	4.52	Yes.	18	1,328	9	33,275	2.00	8.17	22.22
3393	94.63	1.77	3.6	Yes.	17	1,753	73.5	16,500	10.13	69.55	14.56
3751	87.4	2.1	10.5	Yes.	20	1,529	8	33,022	2.63	6.99	37.55
4132	82.02	6.18	11.8	Yes.	23	1,032	77	5,610	7.50	63.15	11.87
4135	72.54	14.13	13.33	Yes.	22	1,065	50	11,396	6.00	36.27	16.54
4232	63.85	16.79	19.36	Yes.	26	1,037	58.5	3,844	5.00	37.35	13.39
4267	81.31	4.38	14.31	Yes.	21	1,164	43.5	29,261	5.70	35.37	16.12
Average.	86.44	4.89	8.68		15.75	1,580	51.47		7.63	44.31	18.78

[a] 75 per cent of the samples contained dodder.
[b] Total quantity of low-grade alfalfa seed imported, 275,572 pounds.

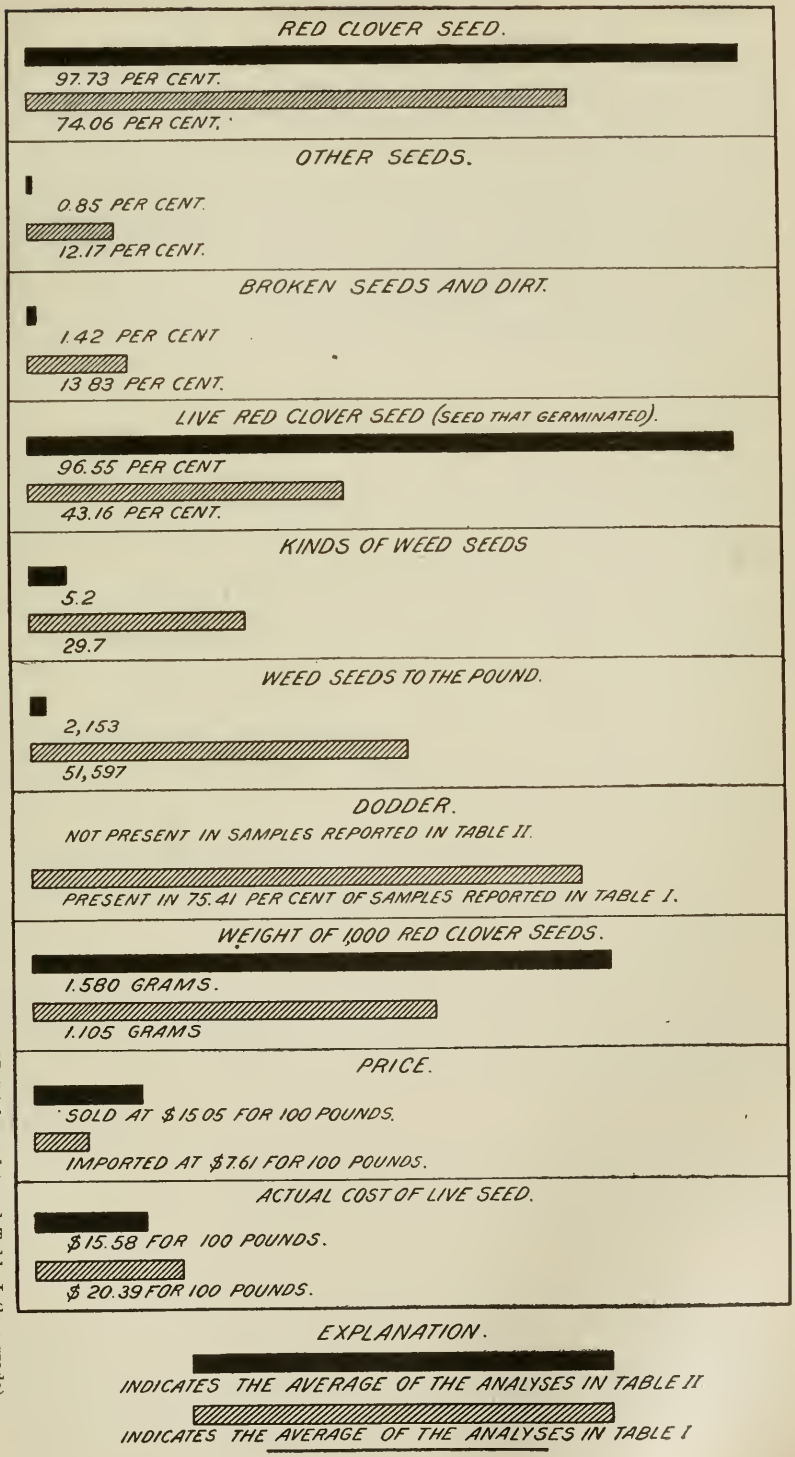


FIG. 4.—High-grade red clover seed compared with low-grade red clover seed: Averages of analyses shown in Table II (high-grade) and Table I (low-grade).

THE IMPORTATION OF LOW-GRADE SEED SHOULD BE STOPPED.

Every pound of worthless seed imported is finally sold to the farmer. Some of it goes into the trade to fill the demand for cheap seed. More of it is used to mix with better seed in the grading-down process. By mixing 100 pounds of seed worth $15 with 100 pounds of imported screenings which cost $7.50, a medium grade will result, costing $11.25 per hundred pounds, which is not sold at $11.25 but at $13 or $14 per hundred pounds. Whenever a dealer mixes two qualities of seed together to make a medium or low grade the price is not reduced in proportion to the quality. In this way the jobber or dealer who mixes seeds invariably gets a profit on the screenings which are used.

Unfortunately many farmers in the United States furnish a ready market for the refuse from our own cleaning mills, and moreover, on account of their demand for cheap seed, we are importing the waste from other countries. Seedsmen should not, perhaps, be altogether blamed for meeting this demand for cheap seed, and they must be expected to sell it as long as there is a call for it. At the same time, the farmer not being as good a judge as the seedsman often takes what is offered at the lowest price and unwittingly pays more for the seed that will grow than if he had bought the best. What is of more importance to the farmer, however, is not that he is paying more for his seed than he should, but that in buying low-grade seed he gets either a poor stand from sowing dead seed, or small, weak plants from sowing seed of low vigor, or the crop is smothered by weeds which will continue to foul the land for many years.

Argentina has a law prohibiting the importation of alfalfa and clover seed containing the seed of dodder. Canada prohibits the sale within her borders of seed containing weed seeds, but provides for its export. Europe is effectually protected from the use of poor seeds through its seed-control stations, but its screenings are exported. It seems time that the United States had some restriction on the importation of seeds of such poor quality that they can not be sold in other countries.

B. P. I.—317.

FORAGE CROPS FOR HOGS IN KANSAS AND OKLAHOMA.

By C. E. Quinn, *Scientific Assistant, Farm Management Investigations.*

INTRODUCTION.

Farmers are more and more realizing that pasture is necessary for the most economical production of pork. Those who are raising hogs and putting them on the market with the least cost have their entire farms fenced hog tight. This enables them to give the hogs the range of the meadows and fields when the crops have been harvested. Much that would otherwise be lost is thus saved by the hogs, for they are among the best gleaners of the waste grain, weeds, and insects in the fields.

More hog pastures are fenced each year, more experimenting is being done, and there is more inquiry as to the best crops for pasture. These questions can not be answered intelligently without a knowledge of the conditions of soil and climate, the market, and the adaptability of crops to different sections of the country.

The Office of Farm Management Investigations has undertaken to ascertain by a study of farm practice: (1) What crops have been found best for pasture for hogs in different localities; (2) the season during which these crops are available; (3) the number of stock they will pasture to the acre; (4) the value of this pasture in connection with other feeds; (5) the quantity of grain necessary to produce a given amount of pork on different pastures; and (6) the cost of producing pork.

While only a small beginning has been made, the demand for such knowledge and its importance to the swine industry of the country has prompted the publishing of this information for each locality as it is obtained.

CROPS USED IN KANSAS AND OKLAHOMA.

During the past summer (1907) about 150 of the most successful swine growers and pork producers of Kansas and Oklahoma were interviewed on the subject of the crops used for feed. In southern

Oklahoma along the river valleys and in northern Oklahoma and southern Kansas the farmers are favored with a soil and climate that make it possible to produce pork very cheaply. The mildness of the climate makes it unnecessary to build as expensive shelters for hogs in winter as are required farther north, and the open and short winters make it possible to furnish pasture during a greater portion of the year, thus lessening the amount of grain which it is necessary to feed. The main pasture crops for hogs in this region are alfalfa, wheat, oats, and rye, ranking in importance in the order named.

ALFALFA.

It is the testimony of 95 per cent of the farmers interviewed in this region that there is no better pasture for hogs than alfalfa, where it can be grown successfully. Those who have failed with it as pasture owe their failure to two causes. First, the alfalfa has been pastured before it has become well rooted. Young alfalfa is too tender a plant to stand severe treatment except under very favorable circumstances. There are a few farmers who have pastured it the same year it was sown and the alfalfa has survived, but this was on rich, heavy loam soil, usually creek bottom or river valley land with water not far below the surface, and the season was very favorable. Ordinarily alfalfa should not be pastured until the second year, and better still not until the third year if it is desired to keep the field as permanent pasture.

The second cause of failure with alfalfa is heavy pasturing and lack of judgment in pasturing in unfavorable seasons. A good many farmers have sown a small piece of alfalfa, and then because it has grown rapidly and all kinds of stock are fond of it they have turned all the stock on the farm on it and have wondered why their alfalfa was killed out. Others pasture regardless of whether the ground is muddy or whether the season is dry and hot. In either case heavy pasturing is very likely to cause the alfalfa to be killed out.

ALFALFA PASTURES.

As to the amount of pasturage or the number of hogs alfalfa will carry per acre without injury to the crop, the estimates given by farmers vary considerably, depending on the kind of soil, the fertility of the land, and the size of the hogs pastured. The following, however, is a safe average estimate as given by conservative men who have had much experience. River valley and creek bottom land well set in alfalfa will carry from 15 to 20 head per acre of 50 to 125

pound hogs. Upland of fair average fertility will support from 8 to 10 head of the same kind of hogs. There are fields that have supported 25 head per acre all through the season for a number of years and are still in good condition, and there are other fields that will not furnish pasture for more than 5 head per acre; but these are extremes. When a field is used only for pasture it is better to divide it into several lots and move the hogs from one to the other as occasion requires.

The length of the season during which this pasture is furnished also varies. Alfalfa is ready for pasture on the average from the middle of April in southern Oklahoma to the middle of May in northern Kansas. In many cases it will do to pasture earlier, but it is not best, as the young alfalfa has not the start it should have for heavy pasturing, nor has it the strength in the plant. When not pastured too early it will furnish feed at the rate mentioned during nearly the whole season until October in the North and November in the South. In some years the pasture season will continue a month later in the autumn, depending on the rainfall and the lateness of cool weather. In some seasons, if the summer is unusually dry and hot, the pasture will become short; but usually pasture for the number of hogs previously specified can be depended on for about seven months of the year in the southern limit of the territory named and for about five months in the northern limit. This rule will apply to other sections of the country in the same latitude as Oklahoma and Kansas.

While many farmers pasture alfalfa fields to their full capacity, in some sections, especially in northern Kansas, it is customary to run about half as many hogs as the alfalfa fields will support. This practice permits the cutting of the usual number of crops of hay, though the yield of hay is, of course, reduced.

Alfalfa not only furnishes a great amount of pasture, but it is of a character that goes to make bone and muscle. It belongs to the leguminous family of plants, as do the clovers, the cowpea, the field pea, the soy bean, and the vetches, and while it is furnishing this valuable food it is at the same time adding fertility to the land. Alfalfa pasture or alfalfa hay and corn are very nearly a balanced ration for animals, and while it is better to have a grain ration fed with it to hogs as well as other animals, yet a healthier, thriftier hog can be raised on alfalfa alone than on corn alone. Many instances are found where hogs have been raised on alfalfa alone. One Oklahoma farmer marketed in December, 1905, 61 head of spring pigs eight months old that averaged 171 pounds. These hogs had run from the time they were little pigs with their mothers on 15 acres of

alfalfa without any grain. They sold on the market for 5½ cents a pound. This made the cash value of the alfalfa pasture about $38.35 per acre. As will be seen, this is light pasturing, as there were only about 4 pigs per acre besides the brood sows.

As already stated, it is much better economy to furnish a grain ration with the pasture, as it results in better gains and a better product. One man estimates that it takes from one-half to one-third less corn on alfalfa pasture than on a straight grain ration to make a hog ready for market. Many let the hogs run on alfalfa until about five to six months old, by which time they reach a weight of 75 to 125 pounds, feeding just a little grain; then they feed heavily for about two months and sell the hogs at eight months old weighing 200 to 225 pounds. One farmer, who raises about a thousand hogs a year and who in one year sold $11,200 worth of hogs, makes a practice of growing his hogs on alfalfa pasture until about eight months old, feeding one ear of corn per head daily. He then feeds heavily on corn for a month or two and sells at an average weight of 200 to 225 pounds. Another man feeds all the corn and slop the pigs will clean up, all the while running them on alfalfa pasture, and sells at six to eight months old at weights of 250 to 300 pounds. Another, who raises about a thousand head a year, feeds all the corn the pigs will eat, beginning shortly after weaning and continuing until the hogs are sold at ten to eleven months old, averaging about 275 pounds.

Still another farmer, from weaning time (two months old) until eight months old, feeds the pigs nothing but dry corn on alfalfa pasture, averaging about one-half gallon of corn (3½ pounds) a day per head. At the end of eight months he sells at an average weight of 250 pounds. Feeding the above quantity of corn a day makes the amount fed about 11¼ bushels per head. Figuring this at the average price of corn in this locality, 35 cents, and the price received for pork, 5½ cents, the following results will show the cost of growing pork on this farm and the value of alfalfa pasture:

Value of 250-pound hog, at 5½ cents	$13.75
Value of pig at weaning, 50 pounds, at 5½ cents	2.75
Gain from pasture and grain	11.00
Cost of 11¼ bushels of corn, at 35 cents	3.93
Value of pasture per head pastured	7.07

Now, compare these results with those of a man who had to depend on other pasture crops than alfalfa. He estimates that it will take 15 bushels of corn on wheat, oats, and rye pasture to raise and fatten a hog so it will weigh 240 pounds at nine months old, besides the pasture and slop. At the price of corn mentioned, 35 cents a bushel,

and with hogs at 5½ cents a pound, note the cost of producing pork on this farm:

Value of 240-pound hog, at 5½ cents	$13.20
Value of pig at weaning, 50 pounds, at 5½ cents	2.75
Gain from pasture and grain	10.45
Cost of 15 bushels of corn, at 35 cents	5.25
Value of pasture per head pastured	5.20

The pasture specified here will not support more than half as many head per acre on this farm by feeding corn all the time. The value of this pasture is only $5.20 per head, against $7.07 per head for alfalfa pasture on the other farm.

The experiences of these men are sufficient to show the value of alfalfa pasture alone, and its greater value when grain is fed in connection, and that it is an important factor in economic pork production. A little later in this bulletin will be given the feeding systems of some farmers which will still further show the excellence of this forage crop and others and the cost of producing pork under such systems.

ALFALFA HAY.

While alfalfa pasture has been found to be very valuable for hogs, the hay as a part ration for winter is scarcely less important. Throughout the region referred to the farmers are feeding the hay to hogs in winter. Many feed the hay by throwing it on the ground in forkfuls; others have made low racks in which the hay is placed, where the hogs can feed like cattle or sheep. The hay has been found to be especially valuable for brood sows before farrowing. Where it is fed during the winter only a small grain ration is necessary to keep the sows in good flesh and in healthy condition. Sows thus fed also farrow good litters of strong, healthy pigs.

The hay is usually fed dry. The leaves are more readily eaten by the hogs than the stems, as they contain more of the nutritive value of the plant. For this reason some farmers save the last cutting of hay for the hogs because it is more relished. It is eaten up cleaner, as the stems are not so woody, and more food value is found in the leaves. Sometimes the hay is cut up fine, wet, and mixed with other feed, and sometimes it is fed ground, as there are now alfalfa mills scattered throughout the alfalfa regions. But it is very doubtful whether this extra expense will pay, unless it be for a ration for young pigs.

To avoid the expense of cutting or grinding, some farmers in order to get the hay all eaten have soaked it in water and fed it. This has proved very satisfactory where tried. One Oklahoma farmer carried his hogs through a winter by feeding them alfalfa leaves soaked in hot water for one day and the next day shorts mixed with the pulp and water. He feeds much alfalfa hay to his hogs and is very successful with them. He puts the last cutting in shock as soon as wilted, and thus cures it without bleaching and feeds it to his hogs. Another farmer carried his entire herd of hogs through the winter by feeding them the pulp of alfalfa hay after soaking it in water over night. He also gave them the water to drink. This was all the feed they had during the winter, and they were in good flesh in the spring, with smooth glossy coats of hair. A Kansas farmer was feeding a bunch of 50 fall pigs on corn; during the winter they got off feed and were not thrifty. He reduced the corn and gave a ration of two-thirds chopped alfalfa hay and one-third corn meal, the two soaked together. The hogs began to do better, and a little later he changed the ration to one-third alfalfa and two-thirds corn. The results were very satisfactory, and the cost of feed was reduced from $15 a month on corn to $9 a month on alfalfa and corn. So alfalfa hay, as well as pasture, has a very important use on a hog farm.

WHEAT.

In northern Oklahoma and southern Kansas fall wheat is a staple crop. It is generally seeded from the middle of September to the first of October. The seeding is usually 1¼ to 1½ bushels per acre. If the ground has been well prepared and the fall is not too dry, this will have made a good growth by the time alfalfa pasture is beginning to fail, along in November. The season here usually remains open until Christmas, so that six weeks of very good pasture are furnished. Some winters are so open that the wheat remains green most of the winter and stock find pasture all winter. The spring opens up by the last of February and the wheat gets green again in March. By judicious pasturing, not pasturing too heavily or when the ground is muddy, much green feed may be had without injury to the wheat. The farmers here have taken advantage of this, and where they have their wheat fields fenced hog tight they turn the hogs from the alfalfa field to the wheat field in November and leave them there during the winter unless the wheat gets too short or the ground becomes muddy. The hogs remain in the wheat until April and do well with very little grain. At this time they can go back to the alfalfa field again. Thus, green pasture is furnished the year round.

Where this is possible two litters a year of 200-pound hogs can be raised with profit and pork produced very cheaply.

Wheat will not carry as many hogs to the acre as alfalfa. The usual number is about six head per acre, though some farmers claim that the maximum is about ten. One man claims that hogs are one of the best animals for pasturing on wheat, not trampling it out as cattle or horses do. Another farmer of large experience thinks it is dangerous to pasture pigs at about weaning time on wheat. He has lost twice, he thinks, from that cause. The last time he saved only 15 out of 45 head. He claims that wheat is too fibrous and collects in balls in a pig's stomach and intestines, causing inflammation, from which the pig dies. It is claimed by some farmers that wheat is injurious to hogs just as it begins to shoot in spring. More information is needed on this point. The usual practice is to remove the hogs from wheat in early spring and put them on alfalfa or other summer pasture, so that experience with wheat pasture later in the season is limited.

The value of wheat as pasture lies chiefly in the fact that it furnishes green feed for the hogs at a season of the year when it is very much needed, especially by young and growing hogs. By having pasture at this season there is a great saving of grain, very little being needed. It also enables fall pigs farrowed in September to be carried through the winter in good condition, thrifty and well grown, so that by giving corn in the spring they can be sent to market by June nearly as cheaply as the March pig can be shipped by December. Quite frequently, where hogs have been grown on alfalfa or wheat pasture, they will, when put on a heavy feed of corn, make a gain of 12 to 15 pounds for every bushel fed.

OATS.

In the same region where wheat is used for pasture, oats are also used for spring pasture and are highly spoken of by all who have used them. Some claim that hogs will do better on oats than on wheat. The hogs like them better and will eat them as long as they grow, while they do not like wheat when it begins to head. In this locality many sow oats in March to furnish spring pasture for the hogs when they come off the wheat and before the alfalfa is ready to pasture. Sometimes oats are sown with rape at this time for the same purpose and to give variety to the pasture. Oats will furnish pasture at about the same rate as wheat.

The great value of oats is due to the fact that they furnish succulent feed at a season when it is much needed, giving variety to the pasture. They are also greatly relished by hogs. Oats are particu-

larly valuable as pasture for sows and young pigs, many farmers sowing them for this purpose. One farmer claims that he is less troubled with scours in pigs on oat pasture than on alfalfa.

RYE.

Rye is not so generally grown for a pasture crop in Oklahoma and Kansas as the crops just discussed. Many farmers, however, use rye to make a part of the pasture crop for their hogs, and its value can not be denied.

Rye is seeded from September 1 to the middle of October. The early seeding is best, as it comes on early and gets well established before cold weather and will thus make better fall and winter pasture. Rye is an excellent pasture for late fall, winter, and early spring. If not pastured too heavily in the spring it will head out and make a very good yield of grain. The grain is an excellent ration to feed with corn to pigs and growing hogs or to grind and mix in slop for sows with pigs.

The amount of pasture furnished by rye is about three-fourths that furnished by alfalfa, being estimated as supporting from 6 to 12 hogs per acre. One man reports having pastured 50 head of hogs on 5 acres during fall, winter, and spring, then harvesting 20 bushels of grain per acre. In the southern part of this region rye would be an excellent cover crop for the soil during the winter. Besides furnishing pasture it could be turned under as a green manure to add humus to the soil.

LESS IMPORTANT FORAGE CROPS.

While alfalfa, wheat, oats, and rye are the principal forage crops, there are others that are used to some extent. Among these are clover, rape, sorghum, cowpeas, soy beans, artichokes, and grasses.

CLOVERS.

The clovers are not generally used in the territory discussed. Among those most used for pasture crops are red clover and white clover. These are good, especially in the latitude of central Kansas and farther north, but south of this the clovers do not do so well. Red clover and white clover are the older pasture crops and are in more general use in the older sections of the country. They are both excellent forage crops for hogs. Red clover comes in well in the rotation of crops; it fertilizes the land and furnishes both pasture and hay. It is often sown with oats or barley in the spring, or later in corn after the last cultivation. It does very well with corn

where there is sufficient rainfall, but in the drier regions this method of seeding clover is not to be recommended. The first fall it is used for pasture; the second season it is used as a pasture and hay crop. It will furnish pasture for about ten head of hogs per acre during the first half of the season and half that many the last half, provided the soil is fairly good and the season not too dry. The hay is excellent for hogs, especially for brood sows in winter, but does not equal alfalfa hay.

White clover is better used in permanent pasture with some of the grasses, as Kentucky bluegrass. It will not furnish as much pasture as red clover, but is especially good while in bloom during May and June. It does better on moist ground than red clover and will do very well on some poor soils. It is not recommended to sow alone nor for hay, although the dry hay contains upward of 14 per cent of crude protein.

Alsike clover is better in some regions than red clover, especially on low, moist ground. In some localities farther north it does better and is a more certain crop. It will supply about as much pasture as red clover, is seeded at the same time, and furnishes pasture for the same period. As a hay crop it will not yield as much, but it is a little better than red clover, as it does not have as woody a stem.

Crimson clover has not succeeded well in the past in this region, but is to be recommended for further trial as a pasture crop. Along the Atlantic coast, the only region where it is largely and successfully grown, it has been found that the hairs of the blossoms are likely to gather in dense balls in the stomach and intestines of animals, especially the horse, and cause death. For this reason it should not be cut for a hay crop after the flowers mature. It is an excellent winter pasture crop for swine, however, and will furnish more pasture than red clover. It is a winter annual, and should be sown in August or September.

The chief value of crimson clover is that it acts as an excellent cover crop for soil during the winter months and prevents the soil from washing or leaching. It also furnishes in southern regions excellent winter and early spring pasture for hogs.

RAPE.

Rape is usually sown in early spring—in March or early in April—in Oklahoma and furnishes pasture by May. The Dwarf Essex variety is used. It is seeded either broadcast, at about 4 pounds of seed per acre, or else in drills 30 to 32 inches apart, using 3 pounds per acre. Drilling is the best method, as this permits of cultivation. The plants grow more rapidly and make pasture sooner. When sown in drills,

the hogs will not break down and destroy so much of the crop. Early-sown rape will furnish pasture from May until August. If rape is not grazed too closely in the spring and the stalk is not eaten off, it will grow up and make fall pasture.

A good growth of rape will supply pasture for about 15 or 20 hogs to the acre. One man claims that it will take 25 head to pasture it down.

It is often difficult to get hogs to eat rape at first if they have not been accustomed to it. For this reason it is not grown by some. Its value as a forage crop, however, is shown in the experiments of the Wisconsin Agricultural Experiment Station, where it was proved to have a feeding value per acre, when combined with a ration of corn and shorts, equivalent to 2,436 pounds of grain and a money value of $19.49 per acre. When the cost of seeding is counted, rape proves valuable for pasture, as the seed can be bought usually for 8 cents a pound and 3 to 5 pounds an acre is all that is needed. Rape should not be pastured until it is a foot high.

Considerable complaint is found with rape because it causes sores and scabs on the hogs. Sometimes the skin has the appearance of being blistered. This is especially true of white hogs. This difficulty can be remedied somewhat by removing the hogs to other pasture crops for part of the time and applying a mixture of sulphur and lard to the sores.

As one of the annual forage crops rape is valuable on account of the cheapness of the pasture, the quantity of feed furnished, the general thriftiness of the hogs on the pasture, and because it adds variety to the ration and is available at a time when other pastures may be short.

SORGHUM.

Sorghum is used quite extensively in the drier upland regions for summer pasture. It is valuable on account of the great amount of feed furnished, pasturing from 20 to 30 head of hogs per acre. It comes in as a summer pasture when other pastures are frequently short on account of hot, dry weather. It is sown in May and furnishes pasture during July, August, and September, or even later.

Sorghum is less palatable and nutritious than many other forage crops adapted to this region. For this reason many do not like it as a pasture crop. Hogs do not thrive as well on it as on alfalfa and require more grain to keep them growing nicely.

The special value of sorghum lies in the fact that it furnishes a great abundance of pasture in dry, hot weather when alfalfa makes little growth. After it is well started, say 2 feet high, it will furnish fairly good pasture for 30 hogs to the acre for a few weeks, and

a good crop will carry 25 head of 100-pound pigs nearly all summer. Generally speaking, it is used only to fill in during dry, hot weather when alfalfa is at a standstill.

COWPEAS.

Cowpeas are just beginning to be recognized in this section as having great feeding and fertilizing value. They do much toward restoring the fertility of the soil, and some farmers are making use of the vines as a forage crop for their hogs. Wherever they have been tried the farmers are enthusiastic in their praise of them. Not enough data have been obtained on pasturing to be able to say how many head of hogs cowpeas will support per acre; but in a comparison of their feeding value with corn for hogs the results obtained by the South Carolina Experiment Station show their importance. In this test 6.02 pounds of corn and 4.91 pounds of cowpeas were necessary to produce a pound of pork. One farmer in Oklahoma reported that his hogs preferred the cowpea hay to alfalfa hay. All kinds of stock are fond of the hay and do well on it.

The value of cowpeas as a forage crop lies in the fact that they furnish a food on which the hogs make good gains. The plants will make a good growth on rather poor soil and furnish feed during late summer and fall when other green crops may be short. They also bring the soil into a more productive state, the same as clover or alfalfa.

If cowpeas are planted in May they will make late summer pasture. The best pasture is obtained after the peas are formed and well grown, as the peas are very nutritious and cause the hogs to gain in flesh rapidly.

In this same latitude in the higher altitudes, as in the San Luis Valley in southern Colorado, where it is too cold for corn, the farmers have found the Canadian field pea a very profitable crop for forage both for sheep and hogs. A large acreage of these peas is put in each year, the peas being sometimes sown alone, but more frequently with oats or barley. The seeding is done in April or early in May, and the crop can be pastured by midsummer. The best season for pasturing however, is later, when the peas have formed, the stock being allowed to harvest the crop. Hogs make a very thorough harvesting, cleaning up the peas and the vines quite thoroughly. What vines are left on the ground, together with the manure, enrich the soil and add more humus to it. In addition to this the labor of harvesting is saved. Some fields, of course, are harvested for hay and make excellent winter forage for cattle, horses, and sheep. The hogs raised in this valley receive no corn. They go on the market as bacon hogs and top the market in competition with corn-fed hogs. These hogs usually get no

farther than Pueblo, Leadville, Silverton, and adjoining towns. The Pueblo packers have been using them for a number of years and speak very highly of them. Thus, the field pea has made the hog industry profitable outside of the corn belt.

SOY BEANS.

The soy bean is used but little as a forage crop by farmers in this section, and the value of this crop is but little appreciated. Soy beans can be planted on a field from which a small grain crop has been removed, and some varieties will make an excellent growth of forage and even mature seed. They will thus furnish pasture for hogs during the latter part of August and September, and the green and ripening beans when harvested by the hogs in this way make an excellent feed. The beans when fed in a ration consisting of one part beans and three to five parts of corn or Kafir corn, as shown by the Kansas Agricultural Experiment Station, make a very profitable ration for fattening hogs. The saving in the amount of feed necessary to make a gain of 100 pounds is from 13.2 to 37.5 per cent and the increase in gain is from 14.6 to 96.4 per cent. Also, in a feeding test at the Indiana Agricultural Experiment Station, where soy beans, middlings, and tankage were used as rations with corn, the soy beans proved to be the most valuable adjunct used. As compared to corn fed alone, hogs that received one-third soy beans to two-thirds corn made two and one-fifth times as much gain in the same length of time. The cost per 100 pounds of gain where corn was fed alone was $5.01 against $3.59 where one-third soy beans and two-thirds corn was fed. Hogs so fed look thrifty, have a good appetite, fatten rapidly, and have glossy hair like animals fed oil meal.

The great value of the soy bean is its power to withstand excessive drought, like Kafir corn, and it will also withstand much wet weather. It is not attacked by chinch bugs and in addition to its great feeding value makes an excellent second crop following wheat or oats to build up run-down or thin soil. Protein is very necessary in a ration for building bone and muscle, as all feeders are coming to know, and the soy bean is exceptionally rich in this. It even stands ahead of alfalfa in this respect.

GRASSES.

The grasses are not so good for hog pasture as the crops previously mentioned, but they are used to some extent. Those most commonly grown are Kentucky bluegrass, English bluegrass or meadow fescue, Bermuda grass, and the native wild grasses.

Kentucky bluegrass is used through Kansas and southern Nebraska. South of Kansas in Oklahoma Bermuda grass is used.

As an example of the value of English bluegrass, the experience of one farmer in northern Oklahoma may be cited. He uses only English bluegrass and wild grass as pasture. On 12 acres of the bluegrass sown the fall before, he pastured 150 head of stock hogs all the spring until about the middle of May. The hogs were then taken off and the grass allowed to go to seed. This farmer states that he harvested a crop of seed larger than the ordinary crop.

Bermuda grass is not much used as a pasture for hogs, but should be grown more in regions to which it is adapted. It is relatively rich in protein, is not easily killed out by pasturing, and withstands drought well. It is often used as a soil binder and might well be used for hog pasture. Many hilly farms that are now washing badly could be put in Bermuda grass and pastured to stock, thus saving the land and building up the soil. Some farmers are beginning to make use of this grass and are fencing it for hog pasture. It withstands heavy grazing, rooting, and trampling.

Some farmers have fenced in the prairie grass and are now grazing their hogs on it. While it does not have a very high feeding value, hogs will do very well on it with grain. One man claims that prairie grass will make hogs hold their own at the rate of 6 head per acre.

ROOT CROPS.

The root crops most used in this territory are potatoes, artichokes, peanuts, and sugar beets.

Artichokes are a very good root crop to use for hogs. They can be planted in the spring the same way as potatoes and cultivated the same. In the fall the hogs can be turned in to harvest them. They thus furnish a good late fall and winter food, especially for brood sows and shoats. One farmer claims that 1 acre will keep from 20 to 30 head in fine condition from October till spring. Their use reduces considerably the amount of corn that must be fed. None of the tubers need be dug except for seed; the hogs will dig the rest. Early in the fall hogs do not eat artichokes readily. In winter and spring they eat them greedily.

Artichokes have a tendency to become a pest on cultivated land, or if planted continuously on the same land they become diseased. They may be grown very successfully, however, in a pasture crop rotation for hogs. As the acreage needed is not large, they can be planted on a part of a field in March or April and the rest of the field sown to rape. In August the part sown to rape can be reseeded to rape for fall pasture. This field can be sown to oats the next spring after rape, and barley sown after the artichokes. The crop may be pastured continuously if needed, or later mowed for hay. In August, after this crop is

removed, rye and clover may be sown. This will furnish pasture for the ensuing fall and for the following year. This makes a three-year rotation of pasture crops that fit in very well with each other. Preparing the land in July and August for the following crop of rye and clover effectually eradicates the artichokes.

The Oregon Agricultural Experiment Station made a test to determine the feeding value of artichokes with grain for hogs. The result of the test showed that where artichokes were fed there was a saving of nearly 2 pounds of grain for every pound of gain in live weight. Besides, the hogs were healthy and vigorous all the time.

The artichoke is superior to the common beets and turnips for hogs—about the same as potatoes—and they are richer in protein than sweet potatoes.

Peanuts are but little used in this region, but farther south and east they are used extensively. One man estimates that when pork is 4 cents a pound, peanuts return $10 per acre when harvested by hogs.

The Alabama Agricultural Experiment Station made investigations as to the relative value of peanuts, chufas, cowpeas, rape, sorghum, and sweet potatoes as pasture crops for hogs. The amount of grain required with peanuts to make 1 pound of gain was 1.77 pounds; with chufas, 2.3 pounds; with rape, 2.68 pounds; with cowpeas, 3.07 pounds; with sweet potatoes, 3.13 pounds, and with sorghum, 3.7 pounds. Five Tamworth hogs in twenty days on Spanish peanuts gained 2.29 pounds a day each.

Peanuts can be very profitably grown in many sections of the latitude of Oklahoma and Kansas. This crop will do better on a sandy loam than on a heavy clay soil, and will make a fair crop on thin soil where corn will not yield well. They are a very good crop to raise, both for pasture and for hay; stock of all kinds are very fond of the hay. When the nuts are left on, it is richer in protein than alfalfa hay. The variety best to grow, both for hay and pasture for hogs, is the Spanish peanut. It is a small-sized nut and grows in great clusters close around the taproot of the plant. The Spanish nut is not so particular in soil requirements as the larger varieties and is easier harvested on account of growing in clusters.

It is claimed that peanuts can be grown in dry regions where corn will not succeed. This, if true, is important in the southern-plains region. Peanuts can be made to take the place of corn in fattening hogs, although the peanut-fed hog makes softer lard and the quality of the meat is not so good, especially in the bacon hog. But as an adjunct to corn the peanut is an excellent forage crop. It is claimed that the northern-grown nut is better flavored and less oily than that grown in the South.

The peanut can be planted the last of April or first of May in the latitude of the regions discussed in these pages and is ready to turn the hogs on by the last of August.

In Colorado, in the sugar-beet district, hogs have been fed quite extensively on beets in the winter. Beets do not prove satisfactory when fed alone, but are used to some extent as part ration with grain. One farmer states that he saves a good supply each year to feed in the winter to his hogs to keep them in a healthy condition.

In a feeding test at the Colorado Agricultural Experiment Station sugar beets proved to be wholly unsatisfactory when fed with grain. The cost per hundred pounds of gain of beets and barley fed hogs was $6.01; of beets and corn fed hogs, $7.22, the latter being higher than any other ration fed.

PUMPKINS.

Pumpkins are an excellent feed for keeping hogs in a healthy condition. Many farmers claim that the seeds of pumpkins will prevent worms in pigs and shoats and that a ration of pumpkins fed with grain will keep hogs thrifty and give them a good appetite. A good many wagonloads can be grown on an acre of rich land. Stumpy land or low moist land will grow good pumpkins.

PASTURE CROPS FOR DIFFERENT SEASONS.

It is not the purpose of this bulletin to discuss the rotation of crops and its importance on the farm, but the aim is to briefly mention the forage crops that are adapted for hogs each month of the year in this region and to explain how they can be made to overlap each other, so that green pasture can be provided for each month in the southern part of the territory discussed and for the greater part of the year in the northern part. Hog raisers know that some months of the year there is an abundance of pasture, while at other seasons there is very little, if any. At such times other feeds must be resorted to that will supply the deficiency. The extra feed required is expensive and cuts down the margin of profit in pork production.

It will not be practicable to name the crop that is best adapted to every locality for the different seasons, as each farmer must know his soil and conditions and adapt his crops to those conditions. The following table will show the crops that may be ready for pasture in the months specified and the possible area of pasture provided, but the choice of one or more of these must be left to the farmer himself.

TABLE I.—*Crops that may be available for pasturing hogs every month in the year, with the number of head an acre will support.*[a]

For pasture during—	In the latitude of—	Crops that may be used.	Time of sowing.	Number of hogs that can be pastured per acre.
April and May	Oklahoma	Alfalfa	Previous year	8–16
		Rye	Previous fall	6–10
		Oats	March 1	6–10
		Rape	do	15–20
	Kansas	Alfalfa	Previous year	8–16
		Rye	Previous fall	6–10
		Clover	do	6–10
		Oats	Last of March	6–10
		Kentucky bluegrass.		8–10
		English bluegrass	Previous fall	8–12
June and July	Oklahoma	Spring rye	March 1	6–10
		Late oats	April 15	6–10
		Sorghum	March 1 to April 1	20–30
		Alfalfa	Previous year	8–16
		Potatoes	March	(Unknown.)
	Kansas	Rape	March 1 to April 15	15–20
		Spring rye	April 1 to 15	6–10
		Late oats	April 15 to May 1	6–10
		Sorghum	April 1	20–30
		Alfalfa	Previous year	8–16
		Prairie grass		5
August and September	Oklahoma	Sorghum	April	20–30
		Cowpeas	May	10
		Soy beans	do	13
		Peanuts	April	8–10
		Alfalfa	Previous year	5–10
	Kansas	Sorghum	May 1	20–30
		Cowpeas	do	10
		Soy beans	do	10
		Peanuts	do	8–10
		Potatoes	April 1	(Unknown.)
		Alfalfa	Previous year	5–10
October and November	Oklahoma	Alfalfa	do	7–14
		Wheat	September 15	6–8
		Rye	September 1	7–10
		Sweet potatoes	May 1	8–12
		Artichokes	March or April	15–25
		Rape[b]	do	15–20
	Kansas	Alfalfa	Previous year	7–14
		Wheat	September 1	5–6
		Clover	March or April	6–10
		Peanuts	May 1	8–10
		Rye	September 1	5–6
		Sweet potatoes	May 1	8–10
		Artichokes	April	15–25
December and January	Oklahoma	Wheat	September 15 to October 1	5–8
		Rye	September	5–8
		Artichokes	April	15–25
	Kansas	Wheat	September 1	5–8
		Rye	do	5–8
		Artichokes[c]	April	15–25
February and March	Oklahoma	Wheat[d]	September 15 to October 1	5
		Rye	September	6–10
		Artichokes	April	15–25
	Kansas	Rye	September 1	5–10
		Artichokes[c]	April	15–25

[a] The number of hogs that can be pastured per acre, it must be remembered, depends on the fertility of the soil, on the season, and on the size of the hogs. This estimate is based on the same figures as were secured on alfalfa pasture; i. e., hogs that weigh from 50 to 125 pounds per head.

[b] Rape will furnish fall pasture as indicated if it is not pastured too close in the spring. It will branch out from the roots and stem in the fall. It may also be planted in August for fall pasture.

[c] Artichokes are available when not frozen. They may be left in the ground until it thaws in the spring, when the hogs will finish harvesting them.

[d] Wheat should not be pastured after the 1st of April if a crop of grain is desired.

SYSTEMS OF HOG FEEDING.

Nearly every farmer who has succeeded with hogs has a feeding system of his own, yet there are some features common to all. A good illustration of the successful handling of hogs on a small farm is that employed by a man in northern Oklahoma on an 80-acre farm. He has his whole farm fenced hog-tight and turns off annually from it an average of 100 head of hogs. All these are of his own raising and are grown and fitted for market with the crops raised on his farm, with the exception that a little corn is occasionally bought. He has 5 acres of alfalfa and each autumn sows 5 acres of wheat for late fall and winter pasture. In the spring he sows oats to supplement the wheat and alfalfa. The wheat is sown at the rate of 1½ bushels to the acre, about September 1, and furnishes pasture in the fall, when alfalfa pasture is getting short, and for a part of the winter. The wheat will also furnish some pasture for the hogs in the spring. The oats tide over until the alfalfa is ready for pasture. Thus, green feed is furnished for the greater part of the year. The rest of his 80 acres this farmer plants to corn. A part of this corn is fenced off and "hogged down" in the fall. As fast as the hogs need it the fence is moved over, and fresh corn is taken in. This pasturing is begun at the same time that corn is usually cut up green and fed to hogs, i. e., when it is in the roasting-ear stage. Spring pigs are turned on this. This plan of feeding is kept up until the remainder of the corn is all husked from the field. Then the hogs are turned in to clean up the waste corn in the field. Last summer cowpeas were drilled in the corn when plowing the last time. These furnished much valuable feed in addition to the corn.

In April this man had 20 head of fall pigs averaging about 125 pounds. These shoats had had no feed except wheat and alfalfa pasture and the waste grain they gathered from the field except a little corn that was thrown to them each day in the late winter and early spring. In April they were put on ground corn for thirty days. During this time each ate an average of one-fourth bushel daily. At the end of thirty days they averaged 225 pounds. This makes an average gain of 3⅓ pounds per day, or a little more than 13 pounds of gain for each bushel of corn fed. The market price of corn was 50 cents a bushel. The hogs sold at $5.50 per hundred, thus bringing 73⅓ cents a bushel for the corn fed.

This farmer raises two litters of pigs a year, farrowed in March and September, turning off fall pigs in the spring and spring pigs in the fall, selling at 6 to 8 months old. From March 15 to November 1, 1906, he turned off $720.50 worth of hogs and had 22 head in the fattening pens, all of his own raising and all grown and fattened on the products of his own farm.

Another farm in the same locality will serve as an illustration of what may be done with fall pigs in this section. Eighty head ran on the alfalfa and wheat fields of the farm during fall and winter. They gathered roughage and waste grain in the fields and were fed no grain until 6 months old. At this age they averaged 135 pounds. They were then fed some corn on alfalfa pasture, the amount gradually increasing till the pigs were on full feed. Corn was fed for two months, during which time the pigs made an average gain of 14 pounds for every bushel of corn fed. They were sold at 8 months old, weighing 235 pounds each. The price of the corn was 45 cents a bushel. This makes the cost of the corn fed $257.14, or $3.21 for each hog. At the average price of hogs in this locality, 5½ cents, the herd averaged $12.92½ per head. Deducting the price of corn fed leaves, as the value of the fall and winter pasture for each hog, $9.71.

Another farmer ran a bunch of September pigs on alfalfa and wheat pastures until the following May, when they weighed 125 pounds. They received in addition one ear of corn each twice a day. At this time the corn was increased gradually until each hog was getting 10 ears twice a day, which this farmer claims is the maximum feed for young hogs. They were fed thus for six weeks, making in this time a gain of about 100 pounds a head and consuming 10 bushels of corn each at a cost of $3.50 a head, or 3½ cents a pound for each pound of gain on corn. Allowing 4 bushels more as the quantity probably fed up to the fattening period at two ears a day, makes the cost for corn for each hog $4.90. To this adding $1.10 a head for pasture and slop (the cost of the slop fed is not known) brings the cost of each hog to $6.50 a head, or 2⅔ cents a pound. This allowed a good margin of profit at the ruling price of pork.

To show the importance of alfalfa hay in a system of feeding, the practice of the farmers around North Platte, Nebr., and elsewhere may be mentioned. The alfalfa hay is ground up fine or else fed whole with corn in the proportion of about 5 pounds of alfalfa to 1 pound of corn. This is fed to the brood sows during the winter, and they come through in excellent condition on very cheap feed. In many sections alfalfa hay is worth about $5 a ton on the farm. One ton of alfalfa and about 8 bushels of corn will keep three brood sows one hundred and thirty days, or nearly the whole winter. The hogs so kept farrow pigs that are remarkable for their vigor and size.

In these times of scarcity of labor and its high price many farmers are trying to reduce the labor on the farm. Some of the hog raisers have adopted the plan of harvesting the corn crop by turning the hogs into the cornfield and letting them gather it, or "hogging it down," as it is called.

One man in Ohio turned 122 spring pigs and older hogs into a 10-acre cornfield in September. The total weight of the hogs was 15,693 pounds. The spring pigs averaged 82 pounds and the older hogs 156 pounds. There was about the same number of each kind. The corn would yield about 60 bushels an acre, and in it there were a good many pumpkins. The hogs had access also to a 5-acre clover field from which the seed had been removed. Water was hauled to them and they had the shade of the woods near by. In twenty-eight days the hogs had gained 6,522 pounds. At this time 57 head were sold, averaging 245 pounds, bringing $5.15 per hundred. The remainder were not sold, but the farmer was offered $5 per hundred for them. Counting the entire gain of 6,522 pounds at $5 would make $327.60, or $31.20 per acre for the field. This paid 52 cents a bushel for the corn which on the market was worth 40 cents. The whole herd of hogs made an average daily gain of 1.92 pounds.

Another man in southern Kansas makes a practice of "hogging down" corn. He uses a portable fence and fences off 5 to 10 acres at a time, taking in more as needed. He turns the hogs in the corn in August. On 12 acres of corn one year he fattened 50 head of hogs, using about 600 bushels of corn. Of the bunch 42 head were sold, averaging 240 pounds, netting $600. Allowing 100 pounds gain for each hog on the corn thus fed, the corn brought 41½ cents a bushel, without the expense of gathering.

Another man in Oklahoma has been "hogging down" corn for a number of years. About 500 head of hogs are turned off this farm every year. By gathering and weighing corn beside that which was gathered by hogs, it was found that a bushel of corn "hogged down" will make as much pork as the same quantity husked and fed, while the expense of harvesting is saved; besides saving the labor of feeding the corn to the hogs the field is also cleaned up better than a husked field.

An Iowa farmer began hogging down corn several years ago, using 20 acres the first year. He watched carefully the feeding of the hogs on this field and concluded that no more corn was wasted than would have been left in the field by the average husker. Since that time he has hogged down all his corn, thus saving the expense of husking. This man says the cost of husking for one year will fence the field hog-tight if there is already a wire fence for cattle. Husking 40 acres of corn yielding 40 bushels per acre, at 4 cents per bushel—it has cost nearer 5 cents the last season (1907), figuring board, etc.—amounts to $64. If the 40 acres are a square field this allows 20 cents a rod for the fence the first year. With a cattle fence already provided this will buy the wire to make it a good hog-tight fence. Besides this there are two other great objects to

be attained by this method of harvesting corn: (1) The improvement of the land and (2) the health of the hogs. The farmer referred to says that in his first year's experience he snapped 20 acres of corn beside the field hogged down. The next spring both were sown to small grain under the same conditions and with the same preparation. The wheat on the land where corn was hogged down made 5 and the oats 7 bushels more to the acre than did the other. The difference is just as noticeable in a succeeding corn crop. The husks, cobs, stalks, and leaves all remain on the land, and these, with the manure from the hogs, enrich the soil and add organic matter to it.

The health of the hog is another important item. Hogs that have plenty of range and exercise are not nearly as susceptible to disease as those confined in a small pen. A hog that goes out after his feed will be well grown and thrifty, accustomed to the elements and not liable to be injured by a sudden change of weather. It is difficult to put a good finish on hogs while running in a large pasture. If they are allowed to run on good pasture until three weeks or a month before sending to market, and are then shut up and given all the corn they want, with plenty of pure water, they will make very rapid gains.

This man allows his pigs to run in the corn as soon as the land is plowed the last time, but does not let the older hogs into the field until the corn is in good condition to feed in the fall. He says he has also had good results from letting cattle into the corn first and following these with hogs. He thinks this is the most practical solution of the labor problem when help is so high-priced and scarce.

As stated in the beginning, it is the aim in this bulletin to deal with some of the practical problems that are confronting the farmers of this country. Facts that have come under the writer's observation in the past year (1907) have been stated as concisely as possible and applied to the territory visited and to similar latitudes. It is impossible, as already stated, to prescribe for the wants of each individual farmer in the limits of a bulletin such as this. The facts are given in a general way, and it remains for each hog raiser to pick and choose for himself as his judgment dictates.

B. P. I.—322.

THE CULTURE AND USES OF BROME-GRASS.

By R. A. Oakley, *Assistant Agrostologist, Forage Crop Investigations.*

INTRODUCTION.

It is the purpose of this bulletin to describe some of the more general methods used in the growing and utilization of brome-grass in the sections where it is now of most importance, and not to discuss in complete detail its culture throughout the entire United States. While the methods described are those employed in North Dakota, South Dakota, and the Canadian Northwest, they are also applicable in general to all other sections where this grass can be grown. The treatment given the subject is slightly inconsistent, since the methods actually practiced by the farmers and the suggestions and conclusions drawn by the writer from his investigations are combined in such a way as not to make them entirely distinct. It is hoped, however, that the matter will in this form be of more assistance to those contemplating the growing of the grass than were another plan of arrangement followed.

Brome-grass (*Bromus inermis* Leyss.), sometimes called smooth brome or Hungarian brome, is a vigorous perennial grass, possessing aggressive underground rootstocks by which it propagates readily. In general, it grows from 15 to 30 inches high, but under exceptionally favorably conditions it attains a height of 4 feet or more. The seed is borne in an open panicle closely resembling that of the well-known chess, or cheat, and is produced abundantly. (See Pl. V, fig. 1.) Although the grass is inclined to mat at the base, the entire stem is also quite leafy. (See Pl. V, fig. 2.)

Brome-grass was introduced from Europe about 1880 and has attained considerable importance in North Dakota, South Dakota, and the Pacific Northwest. It is grown in this country to some extent throughout the general region from Kansas north to the Canadian boundary and west to the Pacific coast, but its importance in the timothy and clover region is at present very limited. The grass is capable of withstanding severe cold and extended periods of drought, but it is seriously affected by heat, and consequently can not be grown successfully south of the southern boundary of Kansas except at high altitudes or under otherwise favorable conditions. It does well on

a variety of soils, but gives best results on soil that is well supplied with humus. It can, however, be grown very successfully on sandy or gravelly land.

In the Dakotas and the closely adjacent sections brome-grass is of more importance than in any other portion of this country. It has been grown in this region for twelve or fifteen years, but is as yet not so widely distributed as would be expected. Improved methods of growing alfalfa, making that crop more certain, are in a measure responsible for the comparatively limited use of brome-grass. This is true more especially in South Dakota than in North Dakota. In sections where alfalfa can be grown brome-grass can not compete with it as a hay crop. In the more humid portion of the above-named States and on the better classes of soil it has the reputation of being difficult to eradicate, and, whether this is warranted or not, this belief has a decided tendency to make the grass unpopular in such sections. For the above reasons and because there is still a considerable quantity of native hay produced, and consequently not such a pressing demand for cultivated grasses, brome-grass has not attained more importance than is the case at present.

METHODS OF CULTURE.

PREPARATION OF THE SEED BED.

For the preparation of the seed bed it is the common practice to plow the ground as early as possible in the spring, which in most sections is in March or very early in April. It is then put into condition for seeding by a thorough harrowing, or by disking, harrowing, and rolling. A careful preparatory treatment is considered essential in the securing of a good stand of grass. Some successful growers favor fall plowing, since this puts the land in better condition for seeding in the spring. Brome-grass follows all crops with practically the same results. It does well after corn, as well-cultivated corn ground is usually quite free from weeds. Wheat and oats, however, are most commonly the preceding crops.

SEEDING.

The seed is usually sown during the first part of April or as soon as the weather is favorable, which may be even as early as the latter part of March. One bushel (14 pounds) to the acre is considered by most growers to be a sufficient quantity of seed to produce a satisfactory stand, and good results are often obtained with 10 to 12 pounds. At the Manitoba experimental farm 10 pounds of good seed is recommended, and 10 to 12 pounds at the Saskatchewan experimental farm.

Bul. 111, Pt. V Bureau of Plant Industry, U. S. Dept. of Agriculture.

FIG. 1.—A PANICLE OF BROME-GRASS (BROMUS INERMIS) IN FULL BLOOM.

FIG. 2.—A SINGLE PLANT OF BROME-GRASS (BROMUS INERMIS).

If desired for pasture alone, it is considered well to sow as much as 20 to 25 pounds to the acre, since this quantity gives a stand that will make good grazing sooner after sowing than a light seeding. Heavy seeding is advised for sections where the grass is being introduced or is not commonly grown. The decrease in recent years in the quantity of seed sown to the acre is due to the fact that home-grown seed is used and better methods are employed in cleaning and sowing it.

The amount of rainfall in any section usually determines whether the seed is sown with or without a nurse crop. In general, in the eastern half of the Dakotas a nurse crop is used, while in the western part, where the rainfall is less, the grass is sown alone. Wheat, oats, barley, and spelt are used as nurse crops and are usually sown at the same rate as when sown alone. The grass seed is sometimes mixed with the grain, but it is a more common practice to drill in the grain, sow the grass broadcast afterwards, and cover by harrowing across the drills. In sowing brome-grass seed with grain it is often difficult to prevent it from being covered too deeply, which usually results in an uneven stand. Difficulty is also often experienced in getting a mixture of grain and grass seed to feed evenly through the drill.

Even in the more humid sections of the Dakotas there is some difference of opinion as to the advisability of using a nurse crop. The best argument in favor of this practice is that returns are obtained from land which otherwise would be practically idle for one year, as the grass yields nothing the first season, even though sown alone. Seeding alone, however, usually gives a better stand, except, perhaps, on weedy land, in which case a nurse crop is quite effective in keeping down the weeds.

In the less humid sections, where brome-grass is most commonly sown alone, the preparation of the seed bed is essentially the same as in cases where a nurse crop is used. When the seed is sown with a drill, it is a good practice to harrow afterwards, as this treatment leaves the ground in a better condition to conserve moisture. The only objection to this method is that it is likely to cover the seed too deeply.

Where fall wheat is grown, brome-grass is sometimes sown with it. By the time the wheat is cut the next summer the grass has made a good growth, and a heavy crop of hay is secured the year following this. Throughout the entire brome-grass region there is some fall seeding done, the time of seeding varying from July to October.

Whether sown in the spring or fall, with or without a nurse crop, brome-grass generally does not make a very vigorous growth and yields practically no forage or seed the first season. When sown alone it is found necessary to mow the grass once during the summer to keep down the weeds. In this case the cutting should be allowed

to remain on the ground. Aside from this, the field receives no attention and in most cases it is not pastured in the fall. When grazed during the autumn of the first year care should be taken to avoid overpasturing.

RENEWAL OF MEADOWS.

Under ordinary conditions a meadow of brome-grass will remain productive for three or four years, depending largely on the kind of soil and the nature of the treatment which it receives. Although it has been grown for a number of years in this country, there has been very little done in an experimental way by farmers to determine the best methods of renewing old meadows. In the Canadian Northwest more attention has been given to this subject, and farmers there have obtained very good results by their methods.

The history of a field of brome-grass is in general as follows: During the season in which it is seeded very little is obtained from it, except, perhaps, a small amount of pasturage; the next year a very fair crop of hay is secured; the third year, a maximum crop; the fourth year the yield is considerably reduced; and following this it decreases rapidly, owing to the meadow becoming what is commonly called "sod-bound." As before stated, the decrease in yield after the third year depends to a large extent on the kind of soil, since on heavy, rich soils the grass usually remains productive for a longer period. The character of the season also is thought to have an effect on the life of the meadow, and some farmers are of the opinion that if conditions are exceptionally favorable for a large crop the second year the grass has a tendency to diminish in yield earlier than if an ordinary crop was produced at that time.

The method of renewal giving best results in the Canadian Northwest and also practiced to some extent in the Dakotas is that of shallow breaking, the time of year depending largely on the amount of rainfall. The experimental farm at Brandon, Manitoba, recommends that the meadow be plowed about 2 inches deep in June or early July, after a crop of hay has been removed, the sod being then rolled and worked down thoroughly. As a result of this treatment a good crop of hay is secured the following season. Farther west, in Saskatchewan and in the drier portions of the Dakotas, breaking the meadow in the spring, about May, gives best results. This method is recommended by the experimental farm at Indian Head, Saskatchewan. Satisfactory results have been obtained in the more humid sections from shallow-breaking the sod in the spring and putting it in condition for a light seeding of grain, oats being frequently used. If thought necessary, 6 to 8 pounds of brome-grass seed is added. In this way a crop of grain is secured the same year, and a good crop of grass the next, so that the ground is not

allowed to lie idle. Returns are of course obtained from the land if the breaking is done in June or July after cutting a crop of hay. In the drier portions spring plowing is necessary, but since grain can not be sown on the sod no returns are obtained until the following year. Good results are sometimes secured from breaking the sod in the fall and sowing oats or some other small grain in the spring. When this is done the grass comes on for a full crop the next year. This method, however, is not commonly practiced.

Disking appears to give better results in the humid than in the drier sections, but in general it can hardly be said to give entire satisfaction. Better results are obtained on sandy or loose soil than on a heavy soil where a tough sod is formed. Farmers who have done very little toward improving their meadows are commonly of the opinion that disking is an effective means of renewing them, but actual experiments indicate that the value of this treatment is considerably overrated. Harrowing with a drag harrow in July after the hay is cut has proved beneficial in some instances.

The practice of applying barnyard manure to unproductive meadows has not been followed to any great extent, and under present conditions it is hardly practicable. The results obtained from such treatment have not been very definite, and in some cases they have been quite contradictory. That a liberal application of barnyard manure, even when no other treatment is given, will materially increase the yield of hay from a so-called "sod-bound" meadow has been proved by reliable and successful farmers. Best results have been obtained by applying an even top-dressing early in the spring before the grass begins to grow. Sheep manure has been found to be very beneficial.

Hardly sufficient evidence has been obtained to warrant definite statements regarding the value of various fertilizers. Prof. J. H. Shepperd, of the South Dakota Agricultural Experiment Station, in the season of 1905 obtained some results that were very favorable to the use of nitrate of soda. At the Highmore station, South Dakota, experiments conducted with the same fertilizers in 1906 gave rather indifferent results. The data available on the subject of renewing meadows by either barnyard manure or commercial fertilizers are so incomplete and the practice of renewal in this way is so unusual that it is not considered advisable to discuss the subject further at this time.

MIXTURES OF BROME-GRASS WITH OTHER GRASSES.

Some attention is being given to mixtures of brome-grass with other grasses, and very good results are being obtained. The practice

so far is very limited, and the proportions of the different grasses to use and the methods of handling have not been well worked out.

At present timothy seems to be the most common grass used in mixtures; alfalfa, red clover, slender wheat-grass, meadow fescue, and orchard grass are also used. Grasses and clovers are mixed with *Bromus inermis* to improve the quality and yield of forage and, for what is probably of more importance, to prolong the period of productiveness by keeping the brome-grass from becoming sod-bound. Results of experiments to determine this period have so far been rather indefinite. It is probable that the sod-bound condition can be delayed for a short while, but not for any great length of time. Alfalfa and clover are of value also, since they tend to maintain the productivity of the soil, and where these plants are mixed with brome-grass they can be pastured with little danger to stock from bloating.

Timothy has been grown with brome-grass at the Manitoba experiment farm with very good results, but it is the opinion there that it does not materially increase the life of a meadow and that the brome-grass eventually crowds it out. This mixture is quite commonly grown throughout Manitoba. Mixtures have been tried on the experiment farm at Indian Head, Saskatchewan, and one composed of 7 pounds of *Bromus inermis* and 7 pounds of slender wheat-grass (*Agropyron tenerum*) has given good results. A meadow of this mixture after having been down for six years without renewing still remained productive, yielding two tons of hay to the acre. In the Dakotas experiments are being conducted with alfalfa and brome-grass, and there is a probability of the combination coming into general use where alfalfa can be successfully grown. Mixtures with orchard grass and meadow fescue have given indications of being worthy of attention. In all permanent mixtures the quantity of brome-grass seed used should be smaller than the sum of the other constituents, as brome-grass has a tendency to crowd out the other grasses.

USES AND VALUE.

PASTURE.

Although grown as a general-purpose grass, *Bromus inermis* is much better adapted for use as pasture than for hay, on account of its tendency to form a turf. It furnishes a large quantity of palatable pasturage, and is especially valuable because it can be grazed early in the spring and late in the fall, and unless the season is unfavorable it furnishes a considerable amount of feed during the summer. Where it is now being grown there are no grasses that can equal it for pasture on sandy land, as it not only produces well on such soil, but forms a sod that withstands trampling and is not easily pulled up

by stock. This is an important feature, especially where sheep are grazed. Even after the grass has become sod-bound and produces only light yields of hay it can still be pastured profitably for two or three years. While it is impossible at the present time to secure definite data in regard to the carrying capacity of *Bromus inermis* pastures, it can be conservatively stated that both in favorable and unfavorable seasons they furnish more grazing in the western part of the Dakotas than the native grasses and more in the eastern part than Kentucky bluegrass.

HAY.

Brome-grass is not an ideal hay grass, although for two or three years after sowing it gives a satisfactory yield of a very good quality of hay. On rich land the yield is better than the average for standard grasses, and the quality is good. (See Pl. VI, fig. 1.) It is generally agreed that the best stage at which to cut brome-grass for hay is just after it has passed full bloom and is in the condition known as the "purple." The practice is, however, quite elastic in this respect, as the grass makes hay of good quality when cut either before or after this stage. No definite feeding experiments have as yet been conducted to determine the value of brome-grass hay in comparison with other standard hays or fodder, but general experience indicates that it is almost, if not quite, equal to timothy for cattle (especially dairy cows), for horses not at work, and for sheep. When properly cured it is very palatable and is relished by all classes of stock, but on account of its laxative properties it can not be recommended as a feed for livery horses or horses at hard work.

Different writers in discussing brome-grass disagree in regard to its nutritive value as compared with a standard grass such as timothy. Chemical analyses disagree also, and it is difficult to compare these grasses, since the samples have been taken at different stages of maturity and also under otherwise different conditions. The average of analyses given in Bulletin 56 of the Iowa Agricultural Experiment Station shows water-free samples of *Bromus inermis* to contain 3.48 per cent of fat and 14.14 per cent of protein, and samples of timothy under the same conditions to contain 4.83 per cent of fat and 12.27 per cent of protein. These analyses indicate that the grasses are near enough alike to be of equal feeding value. The verdict of the feeder, however, is in most cases to be taken in preference to that of the chemist, and it is doubtful whether brome-grass will ever be considered quite equal to timothy as feed for stock.

Brome-grass is usually ready to cut for hay from the last of June until the 20th of July, depending on the locality. When conditions are favorable, it is possible to secure two cuttings, the first about

the last of June or early in July, and the second in September. The securing of two crops depends almost entirely on the amount of moisture and very little on the latitude, since in eastern Manitoba two are frequently obtained. Except under irrigation, only one cutting can usually be secured in the western part of the Dakotas or at the same longitude in Canada. The first cutting yields more and is of much the better quality. The second cutting, although nearly as tall as the first when cut, consists mostly of leaves and makes very light hay.

The hay does not cure as easily as timothy and darkens rapidly if allowed to get wet. Although this makes it unsalable, its feeding value is not seriously impaired. Even when properly cured, however, the hay is of darker color than timothy.

Stacking is done with the ordinary hay-making machinery, and when put up with reasonable care the stacks shed water well and will keep for two years in excellent condition, with but a small quantity of damaged hay on the outside. (See Pl. VI, fig. 2.)

As previously stated, in the third season of growth the maximum yield is usually secured. After two crops are obtained the yield rapidly diminishes. The average yield for the time the meadow is profitable, which is three or four years, may be conservatively estimated at 1½ tons per acre. This is the estimated average yield for the entire region. On good soil and under favorable conditions yields as high as 3 to 4 tons are not uncommon, especially when two cuttings a year can be secured.

Brome-grass hay is very little known on the city market and the demand for it is entirely local. It commands a good price in sections where it is grown, and ordinarily sells for $2 to $3 a ton more than native wild hay and for about the same price as timothy.

SEED.

There is a considerable quantity of brome-grass seed produced throughout the entire region under discussion, although it is grown to the largest extent in the eastern part of the Dakotas, in Manitoba, and in eastern Saskatchewan. The growing of seed in large quantities seems to have been more of an industry a few years ago than it is at the present time. It should not be inferred from this that the total quantity produced is not as great as heretofore, but that farmers are growing it less for wholesale market and more for local use, making its production more generally distributed. Whether there is actually less produced it is difficult to state; there is certainly less imported than formerly. There are many farmers who have in the past grown 100 acres, and even much more, for seed who at the present time are raising little more than enough for their own use.

FIG. 1.—A FIELD OF BROME-GRASS IN NORTH DAKOTA.

FIG. 2.—STACKING BROME-GRASS IN NORTH DAKOTA.

HARVESTING THE SEED.

The seed is mature and ready to cut from July 10 to August 1, and the stage of maturity is commonly termed the "brown" to distinguish it from the "purple," or the stage when the grass is cut for hay. Harvesting the seed is a comparatively easy matter and differs very little from the harvesting of ordinary cereals. The binder and the header are both used, but the former is the most generally employed. When the binder is used the grass is usually cut as high as possible and the bundles put in long shocks to facilitate curing. They are allowed to remain in shocks until thrashed. When the grass can be cut sufficiently high a crop of hay is obtained from the stubble as soon as possible after the seed is removed. This hay is of very fair quality, as it contains a large quantity of green leaves.

While the binder is most commonly used in harvesting, heading appears to be the best method. When it is used, almost all of the grass is left for hay, which makes quite an additional yield from the meadow. After heading, the seed is put up in well-built shocks for curing, and is usually left there from ten days to two weeks or even longer. If conditions are exceptionally favorable, it is possible to thrash directly from the header box. This is not frequently done, since the thrashing machines are not usually ready at that time of the year. The stubble is cut for hay as soon as possible after heading, and yields on an average about a ton to the acre.

Occasionally the grass is cut with a mowing machine and put in ordinary stacks for thrashing. This method is not considered desirable on account of the waste and difficulty in handling.

THRASHING.

Brome-grass is thrashed with the ordinary machine having special riddles and with the wind shut off from the fan to prevent the seed from blowing over. Difficulty is often met with in getting the cleaned seed to elevate properly in the machine, and in many cases the elevator is removed and the seed delivered from the spout at the bottom of the separator. The seed is likely to contain a great amount of chaff and broken pieces of straw after thrashing. This trash is sometimes quite difficult to separate from the seed, and it is necessary to run it through a fanning mill. By withdrawing the bundles from the cylinder after the heads have been thrashed, the seed is kept comparatively free from straw and chaff. This method involves much work and is hardly practicable where a large quantity is to be thrashed.

YIELD OF SEED.

The yield of seed is so variable, depending on the climate, soil, lay of the meadow, and other factors, that it is difficult to estimate the average quantity produced to the acre. From 250 to 350 pounds is, however, a conservative estimate. Records of the Saskatchewan experimental farm show the yield of brome-grass seed there to range from 250 to 600 pounds. Experiments conducted at the Manitoba experimental farm indicate that the harvesting of a mature crop of seed materially lessens the yield of either hay or seed the following year.

On account of the close sod formed by the grass after the first year there are very few weeds present in the fields, and consequently the seed when harvested is practically free from impurities and in very few cases are there seeds of any other grasses in it. There is occasionally a very small amount of seed of the grain used as a nurse crop and a trace of cheat (*Bromus secalinus*) and slender wheat-grass (*Agropyron tenerum*). The seeds of *Bromus inermis* are very similar to those of the above species, the seeds of chess, especially, often being mistaken for brome-grass seeds. (See Pl. VII.)

STRAW.

When cut with a binder, the straw after thrashing is generally stacked and used for feed. The quality varies largely with the height at which the grass is cut, the length of time it stands in the shock, and the care with which it is stacked after thrashing. If all these conditions are favorable, brome-grass straw is about equal to oat straw. At any rate, it makes very fair feed for wintering cattle, horses, and sheep.

USE IN ROTATION.

One of the objections which farmers have to brome-grass is that it is comparatively short lived and will not remain productive for hay in a meadow more than three or four years. This objection is not serious from the standpoint of crop rotation, but, on the other hand, is slightly advantageous, since there is a general tendency to grow one crop on a field for too long a period. *Bromus inermis*, however, is not looked upon by farmers as a valuable constituent in a crop rotation. This is due to the fact that it is considered difficult to eradicate, and when ordinary methods are employed it takes about two years to get it out of the field. Farmers desire something that can be disposed of easily in one year or with one plowing, and consequently are favoring slender wheat-grass (*Agropyron tenerum*), which is now coming into popularity on this account.

SEEDS OF BROME-GRASS (BROMUS INERMIS).

(Magnified six diameters.)

PREPARATION OF BROME-GRASS MEADOWS FOR OTHER CROPS.

The breaking up of a brome-grass meadow and the preparation for other crops is a very important matter. It has been found at the Manitoba experimental farm that plowing the sod after a crop of hay has been cut and the aftermath has made a growth of 3 or 4 inches gives very satisfactory results. The plowing may be done the latter part of June or the first of July and the sod back-set either in the fall or early in the spring and put in condition for wheat or other grains by disking and harrowing. If the aftermath is allowed to grow to the extent above indicated, it assists very materially in rotting the sod and also supplies additional humus. When the breaking is done immediately after a crop of hay or seed is harvested, the sod does not rot well, especially if the season is dry, and consequently the ground is in poor condition for a crop the following spring.

A method which has been found to be practicable, at least in the eastern portion of the Dakotas, is to break early in the spring after the grass gets a good start, then disk and roll thoroughly, and in June sow to flax at the rate of about half a bushel to the acre. In this case, unless the flax makes a good stand there will be some danger of the brome-grass making a sufficient growth to become troublesome. Where flax is a successful crop, it can follow brome-grass to good advantage. No matter what method is practiced, the grass is likely to give trouble the first season on account of its persistence, but if properly handled will not be a serious menace. It is necessary in the drier sections to break the sod when the moisture conditions are favorable, whether in fall or spring, as it is very difficult to break and does not rot readily. On account of the latter fact the sod requires considerable working in the sections of low rainfall.

MISCELLANEOUS USES.

The aggressive nature of brome-grass fits it for certain uses and situations for which the common standard grasses are not adapted. It is very valuable for putting heavy new land in condition for other crops. The rich heavy soil of river bottoms, which are frequently covered with a dense growth of weeds and brush, may be put in good condition by seeding heavily after clearing and plowing. At the end of two years the grass comes on to the exclusion of the weeds and makes an excellent hay meadow.

There are certain classes of soil that after having been plowed for five or six years become very loose and blow badly and are in poor mechanical condition for ordinary crops. When *Bromus inermis* is grown on such land for a few years it adds a sufficient amount of

humus to the soil to return it to good condition. The grass is also very valuable for preventing sandy land from blowing.

Brome-grass is an excellent crop for combating such weeds as foxtail, or squirrel-tail (*Hordeum jubatum*), and on moist land, where the latter flourishes, the former excludes it very effectually.

THE AGRICULTURAL EXTENSION OF BROME-GRASS.

Little has been done in the matter of extending the growing of *Bromus inermis* farther east at the same latitude as its present region. Experiments that have been conducted with it in various sections east of Minnesota and north of Kansas indicate that it is worthy of extension. It will doubtless prove valuable on sandy soil in Wisconsin, New York, and New England, but will probably be of use mostly as a pasture grass and in mixtures with other grasses. In parts of Ohio, West Virginia, Pennsylvania, Maryland, and Virginia where tested it has shown considerable promise. South of these States it is of questionable value.

Brome-grass should be given a thorough test as a sand-binding grass along the Lakes and near the seacoast, as its extensive root system and its ability to thrive on sandy land make it well adapted to such situations. Some very striking results have been obtained with it on sandy soil on the upper peninsula of Michigan. Under similar conditions in Wisconsin its value, especially as a pasture grass, has been quite thoroughly demonstrated. In these States it is said to be at least ten days earlier for pasture in the spring than the ordinary standard grasses.

While the thorough testing of brome-grass by farmers in the States mentioned is strongly urged, its use on a large scale is not considered advisable until its value as compared with the standard grasses commonly grown in these States has been more definitely demonstrated.

SUMMARY.

Brome-grass (*Bromus inermis*) is at present of most importance in the Dakotas and sections adjoining these States, but is grown to some extent throughout the general region from Kansas north to the Canadian boundary and west to the Pacific coast. Its importance in the timothy region is as yet very limited.

It is the common practice to sow the seed in the spring about the 1st of April, or as soon as the weather is favorable. One bushel of 14 pounds is considered a sufficient quantity to produce a satisfactory stand, and good results are obtained with 10 to 12 pounds. Heavier seeding is recommended in sections where the grass is being tested or where it is intended for pasture alone.

Under ordinary conditions a brome-grass meadow remains productive from three to four years, after which it becomes what is commonly called "sod-bound." The meadow can be successfully renewed by breaking the sod lightly, the time of breaking depending largely on the annual rainfall.

Mixtures of brome-grass with other grasses and clovers have proved very satisfactory as far as they have been tried. Timothy, slender wheat-grass, orchard grass, meadow fescue, alfalfa, and red clover are used in these mixtures.

Brome-grass is a valuable general-purpose grass, but is much better adapted for use as pasture than for hay, as it furnishes a large amount of grazing, especially in the spring and late in the autumn. The yield of hay which it produces is good and the quality very satisfactory.

The seed habit of brome-grass is good, which makes it comparatively easy to harvest and thrash. Average yields of about 300 pounds to the acre are obtained.

In crop rotation brome-grass has not as yet become well established, and by some it is looked upon rather unfavorably on account of being somewhat difficult to get out of the land. Good crops, however, are raised after it, and it adds a considerable amount of humus to the soil.

It is often difficult to prepare brome-grass sod for succeeding crops, as it does not rot readily, and for this reason it is necessary to backset after breaking. The time of breaking depends on the rainfall.

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